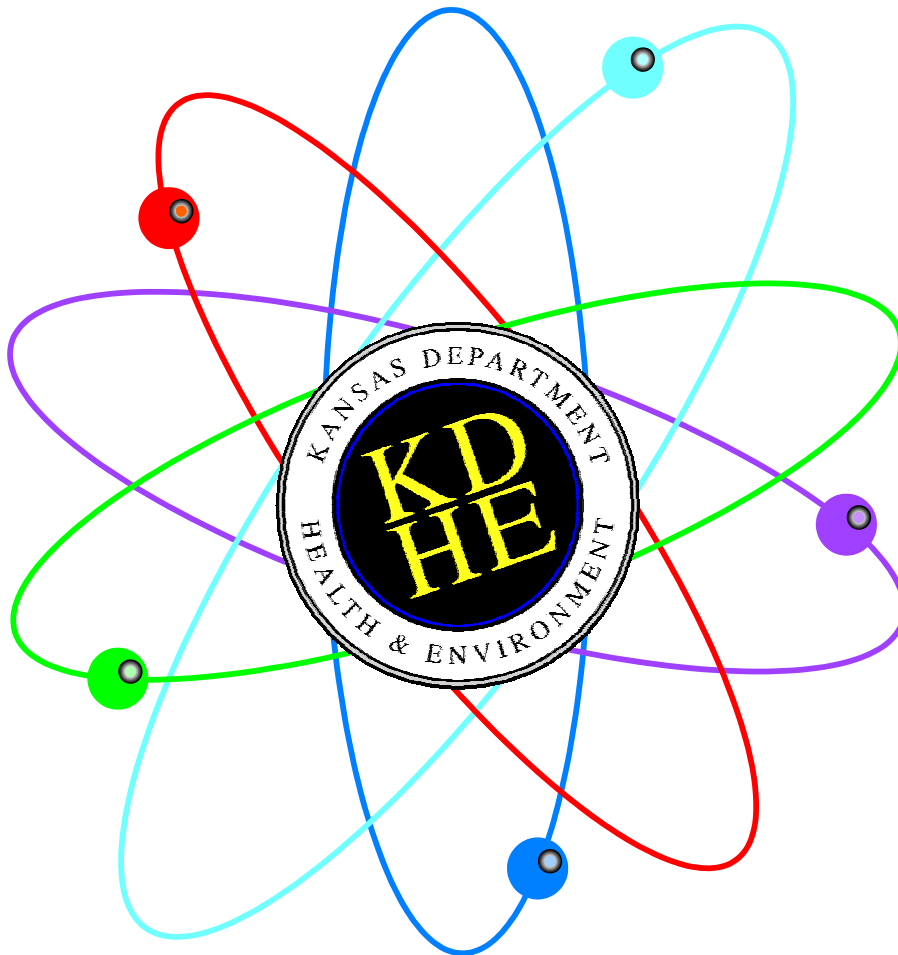


**WOLF CREEK GENERATING STATION
ENVIRONMENTAL RADIATION SURVEILLANCE REPORT**



July 2000-June 2001

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT

**BUREAU OF AIR AND RADIATION
RADIATION CONTROL PROGRAM**

**1000 SW Jackson St., Suite 310
Topeka, Kansas 66612-1366
BUS: (785) 296-1560
FAX: (785) 296-0984**

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WOLF CREEK GENERATING STATION ENVIRONMENTAL RADIATION SURVEILLANCE REPORT SFY 2001

INTRODUCTION

This report covers the results of sampling conducted in the environment surrounding WCNGS (Wolf Creek Nuclear Generating Station) from July 1, 2000 to June 30, 2001 (SFY 2001) by KDHE (Kansas Department of Health and Environment) according to K.A.R. 28-19-81. KDHE's Wolf Creek ERS (Environmental Radiation Surveillance) program began in 1979 with the initiation of selected surface water locations, and was fully set up by 1984.

In July of 1984 a cooperative agreement was established between KDHE and the USNRC (United States Nuclear Regulatory Commission). The cooperative agreement, denoted NRC-31-84-502, established an NRC radiation monitoring network, set criteria for split samples, and designated collocated air sampling stations. The NRC cooperative agreement ended December 31, 1997. The NRC TLD network was dismantled but other program elements remain and are a fundamental part of KDHE's environmental radiation data quality assurance program. This program provides reasonable confidence that the environmental measurements obtained by WCNOG (Wolf Creek Nuclear Operating Corporation), a licensee of the NRC, are accurate and reasonable.

WCNGS became fully operational in 1985, allowing for a year of preoperational data collection for use as a baseline. The purpose of the operational ERS program, instituted in 1985, is to detect, identify, and measure any radioactive material released to the environment in effluents resulting from the operation WCNGS. If elevated levels of radioactivity are detected, this information will then be used to decide whether corrective or protective actions should be taken.

Between September 1999 and March 2000 the ERS program underwent an internal review. This review showed that some improvements in the efficiency and the quality of the science involved were needed. As a result, in July 2000 a revised program was approved and implemented by KDHE. The changes, which include adding random sampling points and some new sample collection and analysis techniques, will be outlined in the paragraphs below. While the primary purpose of the program remains the same, the focus has shifted somewhat to include not only the detection of ongoing effluent releases but to evaluate the long term effects of Wolf Creek operations on the environment of Coffey County and Kansas.

Although not its primary function, the operational environmental radiation surveillance program is also essential to the State's *Nuclear Facilities Incident Response Plan*. If an accidental release of radioactive materials from WCNGS should occur, data collected from air and radiation monitoring sites will be used to accurately calculate doses to affected populations and to assess any environmental impact.

The ERS program includes the following monitoring methods: Measurement of ambient external radiation levels using thermoluminescent dosimetry (TLD), monitoring of concentrations of radionuclides present in ambient air through weekly collection and laboratory analysis of continuous air samples and monitoring of concentrations of radionuclides through the scheduled collection and laboratory analysis of water, milk, terrestrial vegetation, aquatic vegetation, fish, game animal, domestic meat, sediment, and soil samples. A tabular summary of the WCNGS environmental radiation surveillance program conducted during SFY 2001 is presented as Table I.

PROGRAM DESCRIPTION

State personnel performed or were present at all routine environmental sampling, sample splitting with WCNOG personnel, and sample preparation and analysis unless otherwise specified. Sample collection at collocated sites is coordinated with WCNOG environmental personnel so that sample results cover the same period. Where split samples were required, every effort was made to have a KDHE employee present at the time of sample collection. Samples were returned to KDHE labs at Forbes Field after collection. Analyses were done in the KDHE Radiochemistry Laboratory at Forbes Field. State TLDs were processed by the Environmental Radiation and Emergency Preparedness (ER&EP) section of the Radiation Control Program of the Bureau of

Air and Radiation. Program modifications may be made due to specimen unavailability, weather conditions, malfunction of analytical equipment, unavailability of staff, or other unforeseen circumstances.

WCNOC had a contract with Teledyne Brown Engineering Environmental Services for laboratory analysis of samples collected in the WCNGS environs. WCNOC changed their laboratory service to Environmental Inc., Midwest Laboratory, of Northbrook, IL on October 24, 2000. Samples are collected by WCNOC personnel. TLDs are evaluated by Enrico Fermi Unit 2.

Air

Air samples are collected weekly. Five air sampling sites, four of which are collocated with WCNOC, have continuously operating low-volume air samplers contained in a fiberglass housing mounted to utility poles approximately one meter from the ground. Air samplers are located at Sharpe, KS (A-1), East of the Coffey County Lake dam (H-1), Burlington, KS (L-1), New Strawn, KS (P-1), and Hartford, KS (P-2). The collocated sites include the highest calculated annual average ground level relative concentration (P/Q) area at Sharpe, the highest calculated annual average ground level relative deposition (D/Q) area at New Strawn, and a control location at Hartford. An average flow rate of about 30 liters per minute is used with 47 mm diameter glass fiber particulate filters and 5 percent TEDA (Tri-ethylene di-Amine) impregnated carbon cartridges for radioiodine activity (the major isotope of concern is ^{131}I). TEDA acts as a chelating agent to bind the iodine chemically and reduce loss by desorption.

Field assay of each particulate filter and the charcoal cartridge is done at the time of collection. The particulate filter is counted using a thin window GM 'pancake' style detector (Ludlum Model 22-40 or equivalent) and a count rate instrument. A net count rate of greater than two times the net count rate of the current control (Hartford P-2) air sample indicates a potential anomaly and the filter is flagged for individual gamma isotopic analysis. The charcoal cartridge is counted with a 1"x1" Sodium Iodide (NaI) scintillation detector (Ludlum Model 44-2 or equivalent) and a count rate meter capable of single channel analysis set up for ^{131}I using a ^{133}Ba standard. A net count rate of 100 cpm or greater indicates a potential anomaly and the cartridge and its associated filter is flagged for individual gamma isotopic analysis.

Gamma isotopic analysis is done on two composite samples, one composed of the five particulate filters and the other of the five charcoal cartridges. Indication of ^{131}I or any other fission or activation product requires that a gamma isotopic analysis be done on each individual particulate filter and associated charcoal cartridge.

Direct radiation monitoring

Direct radiation monitoring is accomplished by the Radiation Control Program's thermoluminescent dosimetry (TLD) system, which consists of a Victoreen 2800M reader using Victoreen Model 2600-49 axial bulb manganese-doped calcium fluoride ($\text{CaF}_2:\text{Mn}$) dosimeters. Dosimeters are individually calibrated to ^{137}Cs (cesium) and each reading is corrected for fading, self irradiation, and any dose received while in transit.

Thirty-one locations around the WCNGS are monitored by KDHE, including three control locations greater than ten miles from WCNGS. Three bulb dosimeters are used per site to generate an average quarterly reading per site. The dosimeters are contained in specially constructed PVC plastic holders suspended approximately one meter above the ground. Staff exchange TLDs quarterly. KDHE has collocated TLDs with WCNOC at fourteen sites. WCNOC uses Panasonic Model UD-814-AQ TLDs. Each dosimeter consists of one lithium borate element and three calcium sulfate elements in a plastic case.

Surface water

Surface water sampling is done by the collection of one gallon (3.8 l) grab samples at the indicated locations. A control sample is collected monthly below the John Redmond Reservoir dam near the makeup screen house. Two samples are collected from the Coffey County Lake, one monthly at the discharge cove and the other at the spillway if there has been flow during the month. A sample is also collected annually from the New Strawn City Lake.

A gamma isotopic analysis is done on each water sample and tritium (^3H) analysis is done quarterly on a composite sample from each location. Samples split with WCNOG include the control sample at JRR and the two Coffey County Lake samples.

Ground water

Ground water is collected annually at wells in sectors B (control), J, L, and N. The control sample location is hydrologically up gradient from the facility and the other three are hydrologically down gradient. Samples are split with WCNOG.

Gross alpha, beta, tritium and gamma isotopic analysis are done on each sample.

Drinking water

Two public water supplies are sampled for drinking water. These water supplies use the Neosho River as a drinking water source. Burlington is sampled as a control location, being upstream from the WCNGS, and LeRoy, the first public water supply downstream of the WCNGS, is also sampled. Both sites are collocated with WCNOG. At both sites samples are collected from the water distribution system every three years by Bureau of Water (BOW) personnel as part of their public drinking water program. LeRoy samples are collected monthly by Radiation Control Program (RCP) personnel using an installed ISCO sampling system collecting 150 mR every 12 hours over a 30 day period. (See Environmental Radiation Surveillance Procedure RCP/ERS-8 for details.) WCNOG operates and maintains a similar water sampler both at Burlington and at LeRoy. WCNOG water samplers collect 10 mR every hour over a 30-day period. The samples are collected monthly by WCNOG personnel.

Samples are analyzed for tritium, and gamma isotopes. An annual composite of four consecutive quarterly samples is analyzed for strontium (^{89}Sr and ^{90}Sr).

Milk

Milk samples were collected quarterly in Coffey County at a dairy near Lebo. These samples are controls and no indicator locations are available within the 10-mile Emergency Planning Zone of WCNGS.

Each milk sample is analyzed for low levels of radioiodine (major isotope of concern is ^{131}I) and other gamma emitting nuclides. A strontium analysis is done annually.

Sediment and soil

Shoreline sediment, bottom sediment, and soil samples were taken in the environment surrounding WCNGS. Sediment samples for trending were collected annually in the Coffey County Lake discharge cove, public environmental education area (shoreline only), and public fishing area (shoreline only). Sediment samples for trending were also collected on Wolf Creek below the Coffey County Lake dam, and at John Redmond Reservoir. The sediment samples obtained at John Redmond Reservoir are used as controls. The Coffey County Lake and John Redmond Reservoir trending sediment samples are split with WCNOG.

Random sediment samples were collected at 24 locations (12 shoreline and 12 bottom) on Coffey County Lake and 8 locations (5 shoreline and 3 bottom) within the 50 mile Ingestion Pathway Zone (IPZ).

Annual soil samples for trending were collected close to Sharpe, east of WCNGS at the Scott Valley Church (control), east of the Coffey County Lake dam, and at the Coffey County Lake public fishing and environmental education areas. Trending soil samples collected from the Coffey County public use areas are split with WCNOG. Random soil samples were collected at 18 locations within the 50 mile IPZ concentrating in downwind sectors within the 10 mile EPZ.

A gamma isotopic analysis is done on all sediment and soil samples collected. A strontium analysis is done on any sediment sample collected in the Coffey County Lake discharge cove and may be done on other sediment or soil samples based upon the gamma isotopic analysis results.

Fish, game animals, and domestic meat

Semiannual fish samples were collected from the Coffey County Lake and below John Redmond Reservoir on the Neosho River. Sample portions from fish collected in the Coffey County Lake and below John Redmond Reservoir on the Neosho River were split with WCNO. Fish collected at John Redmond Reservoir on the Neosho River are used for control samples. A total of 45 fish were sampled from eight species.

Game animal sampling is usually limited to the collection of edible meat portions from road-killed deer. Sample portions of road-killed deer are usually collected as available by WCNO and split with KDHE for laboratory analysis. No game animal samples were collected during this reporting period.

Domestic meat samples are no longer routinely obtained due to the unavailability of animal husbandry data. As a result pasturage and animal feed sampling has been increased by random sample collection as described below.

A gamma isotopic analysis is done on all samples collected. Sample portions were edible. Tritium in tissue analysis (fat and water) is done on at least one species of fish from each location sampled.

Terrestrial and aquatic vegetation

Terrestrial vegetation samples were taken at various locations around the WCNGS. This includes samples of crops grown throughout Coffey County, broad leaf vegetation taken from gardens near the WCNGS boundary, pasturage near WCNGS, and crops irrigated with water from the Neosho River. Pasturage samples were usually collected concurrently with soil samples. Samples collected on WCNO property, garden vegetables collected from gardens near WCNGS, and samples of crops irrigated with water from the Neosho River, were split with WCNO. There were five annual pasturage, two annual garden trending and four grain (feed) samples collected. There were nineteen random samples for pasturage, food and feed collected.

A gamma isotopic analysis was done on each vegetation sample and edible portions of food products collected.

As available, semiannual aquatic vegetation (algae and rooted aquatics) trending samples are normally collected from the Coffey County Lake, Wolf Creek below the Coffey County Lake dam, and John Redmond Reservoir. The aquatic vegetation samples obtained at John Redmond Reservoir are used as controls. The Coffey County Lake samples are split with WCNO. Due to dry weather and low lake levels for most of the year, only one trending location, the EEA (Environmental Education Area), was sampled during this reporting period. Five random aquatic vegetation samples were collected within the 50 mile IPZ, primarily within the 10 mile EPZ.

Gamma isotopic analysis is done on all aquatic vegetation samples collected. Strontium analysis is done on any aquatic vegetation sample collected in the Coffey County Lake discharge cove and may be done on other aquatic vegetation samples based upon the gamma isotopic analysis results.

EQUIPMENT

The following is a description of the equipment used by the KHEL Radiochemistry laboratory.

Multichannel gamma-spectrometer

Gamma radiation is measured and classified by using a Canberra Genie-2000 MCA System. Detectors available are a Harshaw 3-inch x 3-inch NaI(Tl) crystal, a 105cc (20 percent efficiency) GeLi crystal, a 40 percent efficient HPGe crystal, and a 15 percent efficient HPGe crystal.

Low background alpha/beta system

An Oxford Series 5XLB and a Tennelec 5100 alpha/beta low background IPC system is used for strontium (^{89}Sr and ^{90}Sr), radium (^{228}Ra), and gross beta counting.

Internal proportional counter (IPC)

Gross alpha, uranium, and radium analyses are made with four Nuclear Measurement Corporation (NMC) windowless gas flow IPC systems.

Liquid scintillation

Tritium, nickel (^{63}Ni), and radon (^{222}Rn) in water analyses are performed using a Beckman LS-230 and a Wallac-1409 liquid scintillation system.

Miscellaneous equipment

The Radiochemistry Section has several pieces of equipment used for special projects. A Ludlum Model 2200 single channel analyzer is used with a radon flask scintillation counter for radon and radium analyses. Another Ludlum Model 2200 single channel analyzer is used with a halogen quenched GM pancake probe for routine monitoring of personnel and incoming samples.

QUALITY ASSURANCE

The KDHE Radiation Laboratory has an established internal Quality Assurance program. Quality Control elements include routine calibrations and performance checks on counting equipment, and participation in an environmental radioactivity laboratory intercomparison studies program (see Table 14.0). This program is currently being done with water samples purchased from Environmental Resource Associates.

The KDHE ER&EP section of the Radiation Control Program also participates in international environmental dosimeter intercomparison studies using the State's TLD system. The most recent being the 12th International Intercomparison of Environmental Dosimeters completed Spring of 2001.

Units

The unit of radioactivity used is the picoCurie (pCi). One pCi is equal to 2.22 disintegrations per minute or 0.037 Becquerels (Bq). Radioactivity concentrations in liquids such as water and milk are expressed in picoCuries per liter (pCi/l), radioactivity concentrations in air are expressed in picoCuries per cubic meter (pCi/m³), and radioactivity in solids such as soil or vegetation is expressed in picoCuries per kilogram (pCi/kg). TLD exposure results are expressed as milliRoentgen (mR) per a 90-day quarter. One mR is equivalent to ten micro-Grays (10 : Gy or 10⁻⁵ Gy).

Uncertainty statistics

Radioactive decay of unstable atomic nuclei is a totally random event. The larger the number of total counts obtained and the longer each sample is counted, the closer the measurements will be to their actual value. Due to the large number of samples to be analyzed and the limited time available for counting individual samples, each sample is counted only once and for the minimum time necessary to reduce the statistical error to an acceptable level. Unless otherwise specified, results for all samples are reported at the 95 percent confidence level. Because estimates of systematic (non-random) uncertainties involved in sample collection and sample preparation are highly subjective and generally difficult or impossible to achieve with any substantial accuracy, the KDHE Radiochemistry Laboratory reports only the uncertainty resulting from random processes (propagation of statistical counting error).

A "less than" value reported shows that the radioactivity in the sample is below the lower limit of detection for the procedures, equipment, and counting time used. The KHEL Radiochemistry Laboratory method detection limits (MDLs) for various analyses are summarized in Table 15.0 of this report. MDLs depend on the sample matrix, sample size, counting time, detector efficiencies, and type of measurement required. WCNOC's lower limits of detection values are found in Table 16.0.

RESULTS

Results are reported in the following data tables for the samples taken around WCNGS during SFY 2001. Radionuclides detected in the environment surrounding WCNGS during SFY 2001 include ^{228}Ac , ^7Be , ^{60}Co , ^{137}Cs , ^3H , ^{40}K , ^{226}Ra and ^{228}Th . The isotopes ^{228}Ac , ^7Be , ^{40}K , ^{226}Ra , and ^{228}Th are naturally occurring radionuclides common in the environment. The isotopes ^{137}Cs and ^3H are fission products formed from WCNGS nuclear reactor operation. The isotope ^{60}Co is an activation product, also formed from WCNGS nuclear reactor operation. A small background component of the ^3H (half-life = 12.3 y) and ^{137}Cs (half-life = 30.1 y) activity is due to previous nuclear weapons tests. Small amounts of ^3H are also produced naturally from cosmic ray interactions with water vapor in the upper atmosphere. Background levels of ^{137}Cs and ^3H are accounted for in control samples and in preoperational data. The fission and activation product activity levels found to date in the environment surrounding WCNGS are not above expected regulated levels and are very small when compared with activity levels due to naturally occurring radionuclides.

The most significant radionuclide present in surface water samples collected in the Coffey County Lake is ^3H , a beta emitter. The highest ^3H concentration measured in the Coffey County Lake during SFY 2001 was 28,800 pCi/R in September 2000. This maximum Coffey County Lake ^3H concentration is 144% of the National Primary Drinking Regulation maximum contaminant level (MCL) of 20,000 pCi/R. This level of activity was noted and investigated by both WCNOC and KDHE. It was found that the sample was taken within 24 hours of a normal filtered discharge to CCL. This discharge was permitted by USNRC regulations and was a normal evolution prior to the plant shutting down for a refueling outage. The sample taken the following month was 16,740 pCi/R and by March 2001 had dropped to 13,645 pCi/R (68% of the MCL). *The water from the Coffey County Lake is not used as a drinking water source.* All other surface water, ground water, and drinking water samples collected in the environs of WCNGS during SFY 2001 indicated no radionuclides present attributable to the operation of WCNGS.

Algae, aquatic vegetation and sediment samples are used as indicators for the monitoring of a fission and activation product buildup in the environment surrounding WCNGS. Algae samples have been the best indicators for monitoring the seasonal fluctuations of fission and activation product levels in the Coffey County Lake. The only algae sample collected this year was from the EEA. No algae or aquatic vegetation sample showed any nuclides attributable to WCNGS operation. The maximum naturally occurring activity found in an aquatic vegetation collected in the Coffey County Lake was 10,970 pCi/kg-dry ^{40}K (WCRRA-1-Q-318-1.6). Sediment samples have been excellent indicators for the long term buildup of fission and activation product activity levels in the Coffey County Lake. The highest fission product activity (other than ^3H) during SFY 2001 was 311 pCi/kg-dry ^{137}Cs found in the CCL North cove ENE of Stringtown Cemetery (WCRBS-3-R-329-1.0). It should be noted that the highest non-CCL bottom sediment sample contained a ^{137}Cs concentration of 164 pCi/kg-dry. The highest activation product activity observed during SFY 2001 was 688 pCi/kg-dry ^{60}Co also found in the same Coffey County Lake bottom sediment sample.

Airborne sample analysis showed that no radionuclides attributable to the operation of WCNGS were present above the lower limits of detection during SFY 2001. The highest gross beta+gamma count noted during field screening was 1504 ncpm which was only 204 cpm above the control sample of 1300 ncpm. The highest gross gamma count was 67 ncpm which was less than 100 ncpm and less than the minimum detectable counts of 80 ncpm. Gross count rates vary predictably based on accumulated rainfall, atmospheric dust, air temperature and time of day. All samples did show evidence of short lived beta+gamma activity (<30 minute half life) indicating that high count rates were due to radon progeny.

Sample analysis of terrestrial vegetation, soil, milk, grain, and vegetable samples collected in the environs of WCNGS during SFY 2001 indicated no radionuclides present attributable to the operation of WCNGS.

Sample analysis of edible fish portions collected in the environs of WCNGS during SFY 2001 showed a maximum gamma activity of 5,036 pCi/kg due to naturally occurring ^{40}K in one composite (Wiper) sample from the CCL Discharge Cove. Four edible fish samples collected during SFY 2001 were analyzed for ^3H in tissue (fat and water). A total of 45 fish were taken from the Coffey County Lake during SFY 2001. The highest ^3H concentration in tissue was 9,930 pCi/kg-wet found in a Large Mouth Bass sample taken at the CCL Discharge Cove. Using an ICRP 30 dose conversion factor for ingestion ($h_{E,50}$) of $6.40\text{E-}08$ mrem per pCi ^3H ingested, a standard man consuming 21 kg/y of fish containing 9,930 pCi/kg ^3H would receive a committed effective dose

equivalent of 0.01 mrem. The projected dose equivalent is far below the 100 mrem/y regulatory limit set for an individual member of the public.

Direct radiation monitoring sites showed no significant changes from preoperational data. The grand yearly average of all sites was 76 mR/y, corresponding to 9 : R/h. The lowest direct radiation levels are found closest to the WCNGS. The direct radiation levels on the Coffey County Lake baffle dikes at the 1,200 m exclusion area boundary are the lowest of any monitored site. The average baffle dike direct radiation level for SFY 2001 was 52 mR/y, corresponding to 6 : R/h. Limestone was used to construct the baffle dikes, and has a lower natural background radioactivity than the original soil present before the construction of the Coffey County Lake. This effect of construction on the terrestrial component of natural background radiation was noted on radiation surveys conducted around the WCNGS site before bringing the initial fuel load on the site. The water from the Coffey County Lake also acts as an effective shield from terrestrial radiation that was present before lake filling.

Tables I and II give summary statistics for data collected by KDHE. Data comparisons were made between KDHE and WCNO. The ratio of KDHE results to WCNO results ranged from 1 to 5. A summary of comparison data may be found in Tables III and IV. Data tables, graphs, and figures are also attached.

Table I. Wolf Creek Generating Station environmental radiation surveillance program summary SFY 2001. Tabular summary of sample stations used and numbers of samples collected.

Type of sample	No. of sampling stations	Total samples collected
Air (particulate filter and charcoal cartridge)	5	520
Direct radiation (TLD)	31	384 ^a
Surface water	4	27
Ground water	4	4
Drinking water	1	12
Sediments (Trending Samples)	5	6
Random Sediments	40	32
Aquatic vegetation (Trending Samples)	5	1
Random Aquatic Vegetation	14	5
Milk	1	4
Fish	2	45
Game animals and domestic meat	1	0 ^c
Soil (Trending Samples)	5	5
Random Soil	18	18
Terrestrial vegetation ^b (Trending Samples)	7	11
Random Terrestrial Vegetation	19	19
Grand Total	162	1093

^a Includes control TLDs and TLD's used for transit exposure determination. There are three TLDs per sample station evaluated four times per year.

^b Terrestrial vegetation includes garden vegetables, food products, grain, and pasturage.

^c Domestic meat samples were not collected. This was due to the inability to adequately track the origin of the animal to locations within the Wolf Creek primary ingestion pathway zone. Game animals were not collected by WCNOE environmental services. This sample is usually from road kill game (deer) collected by WCNOE and split with KDHE. No samples of this type were available during the SFY.

TABLE II. Wolf Creek Generating Station environmental radiation surveillance program summary statistics SFY 2001.

Description	Average	Standard deviation	Standard error of the mean	Min	Max	N
TLD direct radiation, mR per 90 day quarter	18.7 ^a	3.7	0.2	8.7	30.5	368 ^b
Airborne particulate and radioiodine cartridge gamma isotopic analysis	Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any air particulate filter or radioiodine cartridge evaluated.					
Surface water tritium (³ H), pCi/R						
John Redmond Reservoir, control (N-1/MUSH)	<350	*	*	<350	<350	4
Coffey County Lake (Q-1/DC, J1A/SP) ^c	16374	2739	1225	12479	19948	5
Ponds surrounding WCNGS	<350	*	*	<350	<350	1
Drinking water tritium (³ H), pCi/R						
LeRoy	<350	*	*	<350	<350	12
Ground water tritium (³ H), pCi/R(All Stations)	<350	*	*	<350	<350	4
Water sample gamma isotopic analysis	Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any surface water, drinking water, or ground water sample evaluated.					
Gamma isotopic analysis of soil, milk, pasturage, garden vegetables, and grain.	Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any soil, milk, pasturage, garden vegetable and grain sample evaluated.					
Maximum activity by isotope attributable to Wolf Creek Generating Station operation, pCi/kg						
Coffey County Lake discharge cove bottom sediment, dry	688±35 ⁶⁰ Co (gamma)					
Coffey County Lake discharge cove shoreline sediment, dry	600±200 ⁹⁰ Sr (beta)					
Coffey County Lake fish, wet	Large Mouth Bass: 9930±1331 ³ H (beta)					
Maximum naturally occurring gamma activity, pCi/kg-dry						
Sector R (WCRFV-06-R-333-5) Pasturage, dry	39415±3346 ⁴⁰ K					

^a Corresponds to 9 : R/h. ORNL/TM-7343 (1981) gives background radiation levels in Kansas ranging from 7 : R/h to 14 : R/h with an average background of 10±1 : R/h (N=6). Measurements were taken along I-70 from western Kansas to eastern Kansas.

^b Total number of TLD readings evaluated (31 locations with 3 TLDs each read 4 times per year).

^c Quarterly composites; includes the Coffey County Lake discharge cove (DC) and the Coffey County Lake spillway (SP). The composite sample for the period July through September contained a monthly sample containing 28,800 pCi/L ³H.

TABLE III. Wolf Creek Generating Station environmental radiation surveillance program data comparison ^a summary statistics SFY 2001.

Description	Average	Standard Deviation	Standard error of the mean	Min	Max	N
TLD direct radiation, mR ^b	18.0 (20.2)	3.6 (2.7)	0.5 (0.4)	10.0 (9.0)	25.9 (27.1)	55 (56)
Airborne particulate filter and charcoal cartridge gamma isotopic analysis	Gamma isotopic analysis by both KDHE and WCNO (Teledyne) showed that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any particulate filter or charcoal cartridge evaluated.					
Surface water tritium (3H), pCi/R						
CCL ^c spillway, J-1A (SP)	15959 (14000)	* (0)	* (0)	* (14000)	* (14000)	1 (2)
CCL discharge cove, Q-1 (DC)	16478 (15878)	3152 (4273)	1576 (1234)	12479 (11527)	19948 (28600 ^d)	4 (12)
JRR ^e below dam (control), N-1 (MUSH)	<350 (* ^f)	* (*)	* (*)	<350 (<152)	<350 (456)	4 (12)
Ground water ³ H, pCi/R	<350 (<189 ^g)	* (*)	* (*)	<350 (<100)	<350 (<200)	4 (4)
LeRoy drinking water ³ H, H-1 (LW40)	<350 (<250 ^g)	* (*)	* (*)	<350 (<200)	<350 (<300)	16 (4)
Surface, ground, and drinking water gamma isotopic analysis	Gamma isotopic analysis by both KDHE and WCNO (Teledyne) showed that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any surface, ground, or drinking water sample evaluated.					
Maximum activity by isotope attributable to WCNGS operation, pCi/kg						
Bottom sediment	Gamma emitter: CCL discharge cove, WCBS-Q-1 (WCBS- 9118), 465±26 ⁶⁰ Co-dry (606±47 ⁶⁰ Co-dry)					
CCL fish	All results for fish indicated that no gamma emitters attributable to Wolf Creek Generating Station operation were present <i>above</i> the lower limits of detection. Beta emitter: Composite of five Largemouth Bass at 9,930±1277 ³ H-wet (9,749±240 ³ H-wet), (Composite of four Common Carp 10,363±255 ³ H-wet)					
Shoreline Sediment	Gamma emitter: CCL discharge Cove Shoreline sample, WCSS-Q-1 (WCSS-9120), 56±7 (52±14) ⁶⁰ Co-dry					
Milk, soil, terrestrial vegetation	Gamma isotopic analysis by both KDHE and WCNO (Teledyne) showed that no comparable gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any milk, soil, shoreline sediments or terrestrial vegetation sample evaluated.					
Maximum naturally occurring gamma activity, pCi/kg						
Sector E Garden sample (Squash leaves) at 24626±2443 ⁴⁰ K-dry, (3530±275 ⁴⁰ K-wet)						

^a KDHE (WCNO).

^b mR per 90-day quarter.

^c Coffey County Lake.

^d KDHE quarterly composites; Wolf Creek monthly analyses. Wolf creek's highest monthly result was 28,600. KDHE analyzed the sample split prior to compositing and the result was 28,800 pCi/R

^e John Redmond Reservoir.

^f If one assumes that the real value is half of the stated detection limit, the average including the 456 pCi/R result, is 116±31 pCi/R. This is lower than the lowest detection limit for the data set (152 pCi/R). Note that 456 pCi/R is well below 20,000 pCi/R drinking water limit.

^g Average of MDA values.

Table IV. Data comparison summary by selected analyses SFY 2001.

Analysis	Average ratio of KDHE results to WCNOC results ^a	Comments
Air particulate filter gamma isotopic	1.8±0.2 N=2	The isotope used for comparison was ⁷ Be (t _{1/2} = 53 days). WCNOC composites particulate filters by location for quarterly analysis. KDHE analyzes a five-filter composite across all locations weekly. The comparison was made using quarterly averages. WCNOC quarterly sample results were available for only the first two quarters of SFY 2001.
TLD direct radiation	0.9±0.0 N=55	Fourteen sites are collocated.
Surface water tritium (³ H)	1.0±0.0 N=6	KDHE analyzed quarterly composite samples, WCNOC analyzed samples monthly. WCNOC monthly analyses were used to obtain quarterly averages for this comparison. The results compared are for the CCL (J-1A(SP) and Q-1(DC)). One monthly sample was also included in the comparison.
Soil gamma isotopic	1.1±0.1 N=4	This corresponds to a relative agreement of 9 %. Isotopes used for comparison were ¹³⁷ Cs and ⁴⁰ K.
Bottom sediment gamma isotopic	0.9±0.1 N=5	This corresponds to a relative agreement of 11 %. Isotopes used for the comparison were ⁶⁰ Co, ¹³⁷ Cs and ⁴⁰ K.
Shoreline sediment gamma isotopic	1.2±0.1 N=5	This corresponds to a relative agreement of 17 %. Isotopes used for the comparison were ⁶⁰ Co, ¹³⁷ Cs and ⁴⁰ K.
Terrestrial vegetation gamma isotopic-pasturage	2.6±0.3 N=4	The results for KDHE are reported as pCi/kg-dry while the WCNOC results are reported as pCi/kg-wet. The wet weight to dry weight ratio for the samples compared was 3.4±0.1. Isotopes used for comparison were ⁷ Be and ⁴⁰ K. When the WCNOC results are normalized to a dry-weight reporting basis, the KDHE/WCNOC ratio improves to 0.8 with a relative agreement of 25 %.
Terrestrial vegetation gamma isotopic-grain	0.9±0.1 N=4	This corresponds to a relative agreement of 11 %. The results for KDHE and WCNOC results are reported as pCi/kg-wet. Isotope used for comparison was ⁴⁰ K.
Terrestrial vegetation gamma isotopic-garden vegetables (squash and horseradish leaves)	5.4±0.8 N=4	The results for KDHE are reported as pCi/kg-dry while the WCNOC results are reported as pCi/kg-wet. The wet weight to dry weight ratio for the samples collected was 5.2±0.7. Isotopes used for comparison were ⁷ Be and ⁴⁰ K. When the WCNOC results are normalized to a dry-weight reporting basis, the KDHE/WCNOC ratio improves to 0.8 (a relative agreement of 25 %).
Aquatic vegetation gamma isotopic	4.8±0.8 N=4	The results for KDHE are reported as pCi/kg-dry while the WCNOC results are reported as pCi/kg-wet. The wet weight to dry weight ratio for the samples collected was 6.5±1.0. Isotopes used for comparison were ⁷ Be and ⁴⁰ K. When the WCNOC results are normalized to a dry-weight reporting basis, the KDHE/WCNOC ratio improves to 0.7 (a relative agreement of 43 %).
Fish gamma isotopic	1.1±0.1 N=13	This corresponds to a relative agreement of 9 %. The isotope used for comparison was ⁴⁰ K.
Fish tritium (³ H) in tissue	1.5±0.5 N=2	WCNOC samples are analyzed for tritium content in the water of the tissue while KDHE analyzes for the tritium content in the fat and water of the tissue.

^a KDHE/WCNOC±SEM. The relative agreement is given by the absolute value of (1-WCNOC/KDHE)×100%.

**WOLF CREEK GENERATING STATION
ENVIRONMENTAL RADIATION SURVEILLANCE REPORT
KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
SFY 2001**

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TABLE 1.0 KDHE weekly samples for airborne particulate radionuclides SFY 2001. Gross beta-gamma field counts in ncpm (net counts per minute). *Weekly five-charcoal cartridge and five-particulate filter composite gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the method detection limits.* WCNOG sample location designations are denoted by parenthesis.

Date	A-1 (2) Sharpe	H-1(18) East of CCL dam	L-1 Burlington	P-1 (32) New Strawn	P-2 (40) Hartford control
07/06/00	424	371	444	445	430
07/13/00	584	520	708	619	1045
07/19/00	437	364	528	501	419
07/26/00	351	368	358	317	487
08/03/00	804	565	945	774	1154
08/10/00	856	686	899	668	1162
08/17/00	517	454	513	458	539
08/24/00	482	446	528	529	450
08/31/00	411	309	358	304	458
09/07/00	456	407	412	413	471
09/14/00	719	598	737	663	663
09/21/00	593	440	601	467	1219
09/28/00	662	814	1504	1361	1300
10/05/00	496	377	542	497	465
10/12/00	467	423	413	379	455
10/19/00	1027	744	978	936	675
10/26/00	233	233	235	196	201
11/02/00	364	306	290	284	327
11/09/00	323	309	356	317	282
11/16/00	457	329	411	376	467
11/22/00	922	655	1029	835	1151
11/30/00	736	613	1083	552	1176
12/07/00	515	526	582	473	408
12/14/00	456	343	403	373	431
12/21/00	323	313	310	239	439
12/28/00	551	436	537	553	535
01/04/01	832	606	449	536	743
01/11/01	149	186	123	162	168
01/18/01	689	705	646	773	765
01/25/01	*	*	467	452	NA
02/01/01	602	485	456	475	567
02/08/01	413	351	391	406	374
02/15/01	309	293	311	246	264
02/22/01	166	140	165	222	162
03/01/01	136	153	138	177	133
03/08/01	330	222	241	245	355
03/15/01	166	132	170	196	187
03/22/01	153	153	150	144	148
03/29/01	148	115	154	170	117
04/05/01	267	189	246	202	310
04/12/01	130	97	132	100	132
04/19/01	181	211	279	213	276
04/26/01	612	467	802	506	541
05/03/01	228	215	272	221	196
05/11/01	268	263	334	304	209
05/17/01	331	268	321	384	364
05/24/01	145	98	163	117	206
05/31/01	157	140	182	177	167
06/07/01	107	*	134	111	129
06/14/01	135	174	151	107	208
06/21/01	137	107	124	118	129
06/28/01	526	391	402	429	540

Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , $^{58/60}\text{Co}$, ^{59}Fe , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , $^{134/137}\text{Cs}$, ^{140}Ba , ^{140}La , $^{141/144}\text{Ce}$, ^{169}Yb , ^{226}Ra , ^{228}Ac , $^{234/228}\text{Th}$, and ^{239}Np . The naturally occurring radioisotope ^7Be was detected on the particulate filter composite samples (0.02 pCi/m³ to 0.23 pCi/m³ with a mean of 0.12±0.01 pCi/m³, N=51). See Figure 1 for sample locations.

TABLE 2.0 Wolf Creek quarterly direct radiation monitoring SFY 2001. Direct radiation monitoring results in mR. Reported results include errors associated with correction factors. Exposures are normalized to a 90-day quarter. Results are expressed as the average of three TLD readings per location \pm total uncertainty (F_{UNC}).^a WCNOG sample location designations are denoted by parenthesis.

Location ^b KS (WCNOG)	QTR 1 (Begin 10-Jul-00)	QTR 2 (Begin 03-Oct-00)	QTR 3 (Begin 04-Jan-01)	QTR 4 (Begin 12-Apr-01)
1. A-1 (1), North of WCNGS	20.1 \pm 2.5	24.7 \pm 1.4	21.9 \pm 1.1	17.9 \pm 1.6
2. A-2, Sharpe	17.3 \pm 1.5	21.5 \pm 1.5	21.2 \pm 1.6	14.0 \pm 1.7
3. A-3, Forward staging area	16.1 \pm 1.5	19.7 \pm 1.5	22.7 \pm 1.3	16.7 \pm 1.5
4. B-1, East Sharpe	19.8 \pm 1.4	24.4 \pm 1.4	25.1 \pm 1.3	17.1 \pm 1.8
5. B-2, Waverly control	14.9 \pm 1.6	23.1 \pm 1.6	18.3 \pm 1.5	17.2 \pm 1.4
6. C-1, near residence	15.8 \pm 1.1	22.5 \pm 1.3	22.7 \pm 1.4	19.0 \pm 2.0
7. D-1 (9), near residence	14.5 \pm 0.8	20.2 \pm 1.9	19.3 \pm 1.1	14.7 \pm 1.5
8. E-1, near residence	17.5 \pm 1.7	23.3 \pm 0.9	20.5 \pm 1.5	16.7 \pm 1.5
9. F-1, near residence	16.7 \pm 1.0	22.5 \pm 2.0	20.7 \pm 1.4	15.4 \pm 2.1
10. G-1 (14), WCNOG gate	19.2 \pm 1.1	23.0 \pm 1.0	23.8 \pm 3.0	16.1 \pm 1.2
11. H-0 (42), CCL baffle dike A	10.0 \pm 0.9	16.8 \pm 0.9	12.8 \pm 1.0	11.9 \pm 1.1
12. H-1, East of CCL dam	17.0 \pm 1.8	23.2 \pm 2.1	18.6 \pm 1.4	16.6 \pm 1.2
13. H-2, LeRoy control	15.8 \pm 2.1	22.4 \pm 1.6	19.1 \pm 1.5	17.2 \pm 2.0
14. J-1, near residence	17.7 \pm 1.8	21.3 \pm 1.4	20.6 \pm 1.0	17.9 \pm 1.1
15. K-1 (29), near residence	14.5 \pm 1.4	19.6 \pm 1.9	14.4 \pm 2.9	13.7 \pm 1.8
16. L-1 (27), near residence	18.4 \pm 0.9	20.5 \pm 1.6	20.7 \pm 1.3	15.6 \pm 0.9
17. L-2, Burlington	17.8 \pm 2.4	22.2 \pm 1.8	19.6 \pm 2.0	17.6 \pm 1.7
18. L-3, Coffey County shop	16.8 \pm 1.2	21.9 \pm 1.0	21.0 \pm 1.5	16.8 \pm 1.3
19. M-1 (26), near residence	17.4 \pm 1.7	20.1 \pm 1.7	17.6 \pm 1.0	15.8 \pm 2.4
20. N-1, near pasture	20.2 \pm 1.3	25.1 \pm 2.0	19.8 \pm 1.5	17.4 \pm 2.7
21. P-0 (43), CCL baffle dike B	10.2 \pm 1.2	17.4 \pm 1.6	12.0 \pm 1.1	11.4 \pm 1.2
22. P-1, New Strawn	17.1 \pm 1.1	21.8 \pm 1.1	19.4 \pm 1.4	17.0 \pm 1.4
23. P-2 (40), Hartford control	15.5 \pm 1.9	*	17.8 \pm 2.0	13.7 \pm 2.0
24. P-3 (45), CCL entrance	19.3 \pm 1.1	20.2 \pm 1.6	20.8 \pm 1.2	17.2 \pm 1.0
25. P-4 (46), CCL near MUDS	19.7 \pm 1.7	18.6 \pm 1.2	21.6 \pm 1.1	16.7 \pm 1.7
26. P-5, JRR public use area	15.9 \pm 1.4	22.6 \pm 1.7	19.0 \pm 1.1	18.7 \pm 1.0
27. Q-1, near residence	18.1 \pm 1.3	21.8 \pm 1.9	20.5 \pm 1.6	15.2 \pm 1.6
28. R-0 (41), Stringtown cemetery	22.8 \pm 2.1	23.9 \pm 1.2	21.4 \pm 1.2	18.8 \pm 1.5
29. R-1 (37), near residence	16.9 \pm 1.0	20.9 \pm 1.1	19.3 \pm 0.9	16.3 \pm 1.1
30. R-2 (44), CCL EEA	17.0 \pm 1.8	25.9 \pm 2.5	18.5 \pm 1.8	20.0 \pm 2.1
31. R-3, near Coffey County airport	17.7 \pm 2.3	21.3 \pm 1.1	21.0 \pm 2.7	15.7 \pm 1.3

^a The total uncertainty is determined by the equation

$$\sigma_{UNC} = \sqrt{\sigma_{ran}^2 + \sigma_{sys}^2}$$

where F_{ran} is the random uncertainty and F_{sys} is the systematic uncertainty associated with equipment and methods (determined by error propagation techniques). A ^{137}Cs energy calibration factor is determined for each TLD. See Figure 3 for sample locations.

^b The Coffey County Lake (CCL) public access areas are the Environmental Education Area (EEA) in sector R, and the fishing area near the makeup discharge structure (MUDS) in sector P.

TABLE 2.1 Wolf Creek collocated quarterly direct radiation monitoring SFY 2001. Direct radiation monitoring results in mR. WCNOC results are expressed as normalized 90-day quarter average \pm two standard deviations of two dosimeters at each location (three TLD chips per badge are used for data evaluation). KDHE results are expressed as a normalized 90-day quarter average \pm total uncertainty (one standard deviation) of three TLD bulb dosimeters at each location.

Location KDHE (WCNOC)	Monitoring period	KDHE	WCNOC
1. A-1 (1)	01-July through 30-Sep-2000 01-Oct through 31-Dec-2000 01-Jan through 31-Mar-2001 01-Apr through 30-Jun-2001	20.1 ±2.5	19.7 ±1.1
		24.7 ±1.4	21.3 ±1.3
		21.9 ±1.1	23.4 ±1.8
		17.9 ±1.6	22.2 ±2.3
2. D-1(9)		14.5 ±0.8	17.7 ±1.0
		20.2 ±1.9	19.4 ±0.8
		19.3 ±1.1	20.8 ±1.7
		14.7 ±1.5	20.7 ±2.1
3. G-1 (14)		19.2 ±1.1	19.1 ±0.7
		23.0 ±1.0	22.0 ±3.7
		23.8 ±3.0	22.6 ±1.6
		16.1 ±1.2	21.6 ±1.2
4. H-0 (42)		10.0 ±0.9	13.2 ±0.7
		16.8 ±0.9	16.7 ±3.0
	12.8 ±1.0	18.4± 1.0	
	11.9 ±1.1	16.3 ±1.2	
5. K-1 (29)	14.5 ±1.4	16.3 ±1.0	
	19.6 ±1.9	17.9 ±1.3	
	14.4 ±2.9	20.2 ±4.6	
	13.7 ±1.8	20.8 ±4.8	
6. L-1 (27)	18.4 ±0.9	19.8 ±0.7	
	20.5 ±1.6	21.3 ±1.8	
	20.7 ±1.3	21.1 ±1.1	
	15.6 ±0.9	22.3 ±1.4	
7. M-1 (26)	17.4 ±1.7	18.0 ±0.9	
	20.1 ±1.7	20.1 ±0.8	
	17.6 ±1.0	22.4 ±6.5	
	15.8 ±2.4	20.9 ±1.1	
8. P-0 (43)	10.2 ±1.2	13.0 ±0.7	
	17.4 ±1.6	16.6 ±3.1	
	12.0 ±1.1	17.8 ±0.8	
	11.4 ±1.2	15.3 ±1.1	
9. P-2 (40)	15.5 ±1.9	16.6 ±1.1	
	*	18.3 ±2.2	
	17.8 ±2.0	20.8 ±1.5	
	13.7 ±2.0	18.6 ±1.3	
10. P-3 (45)	19.3 ±1.1	22.2 ±3.3	
	20.2 ±1.6	20.9 ±0.9	
	20.8 ±1.2	24.1 ±0.9	
	17.2 ±1.0	25.4 ±1.5	
11. P-4 (46)	19.7 ±1.7	18.9 ±1.0	
	18.6 ±1.2	22.8 ±5.3	
	21.6 ±1.1	22.8 ±1.9	
	16.7 ±1.7	22.9 ±1.1	
12. R-0 (41)	22.8 ±2.1	20.4 ±1.1	
	23.9 ±1.2	22.0 ±1.0	
	21.4 ±1.2	27.1 ±4.1	
	18.8 ±1.5	22.1 ±1.2	
13. R-1 (37)	16.9 ±1.0	18.5 ±1.3	
	20.9 ±1.1	20.8 ±2.0	
	19.3 ±0.9	21.4 ±1.0	
	16.3 ±1.1	20.5 ±0.9	
14. R-2 (44)	17.0 ±1.8	20.1 ±2.9	
	25.9 ±2.5	20.4 ±1.7	
	18.5 ±1.8	22.7 ±3.3	
	20.0 ±2.1	21.4 ±2.0	

TABLE 3.0 Wolf Creek quarterly composite of monthly samples for waterborne radionuclides surface water SFY 2001. Sample results in pCi/R Results reported at the 95% confidence level. *Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the method detection limits.* Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . See Figure 2 for sample locations. WCNOG sample location designations are denoted by parenthesis.

Date	J-1A (SP) ^a CCL near spillway	Q-1 (DC) CCL discharge cove	N-1 (MUSH) ^b John Redmond Reservoir below dam control
Tritium (^3H) Quarterly Composite			
09/21/00	15959±387 ^c	19948 ±702 ^d	<350
12/28/00	*	17645 ±284	<350
03/15/01	*	15841 ±380	<350
06/21/01	*	12479 ±373	<350

^a CCL denotes Coffey County Lake.

^b MUSH denotes makeup screen house.

^c J-1A was only sampled twice in SFY 2001. 7/27/00 and 8/17/00. This was due to low lake levels in the CCL. Since there was no flow over the spillway, no samples were taken after August. The 9/21/00 composite was from the July and August samples only.

^d Highest Tritium sample (28,800 pCi/l) at CCL Discharge Cove taken 9/21/00. The 9/21/00 monthly sample was analyzed separately when the analyst noticed anomalies in the composite sample count.

TABLE 3.1 Wolf Creek monthly duplicate samples for waterborne radionuclides in surface water SFY 2001. Gamma isotopic analysis by both KDHE and WCNOG of surface water samples showed that no gamma emitters attributable to WCNGS operation were present above the lower limits of detection. Sample results in pCi/Rtritium (^3H).

Date	J-1A (SP)		Q-1 (DC)		N-1 (MUSH) control	
	KDHE	WCNOG	KDHE	WCNOG	KDHE	WCNOG
07/27/00	*	14000 ±300	*	16000 ±400	*	<160
08/17/00	*	14000 ±1000	*	16000 ±1000	*	<200
09/21/00	15959 ±387	*	19948 ±702 ^c	28600 ±500	<350	<182
10/19/00	*	*	*	16740 ±375	*	<181
11/16/00	*	*	*	15578 ±350	*	<152
12/28/00	*	*	17645 ±284	15189 ±347	<350	<159
01/18/01	*	*	*	15726 ±251	*	456 ±75
02/15/01	*	*	*	14775 ±352	*	<158
03/15/01	*	*	15841 ±380	13645 ±340	<350	<184
04/19/01	*	*	*	13314 ±326	*	<152
05/24/01	*	*	*	13446 ±341	*	<186
06/21/01	*	*	12479 ±373	11527±300	<350	<173

TABLE 4.0 Wolf Creek annual samples for deposition of airborne radionuclides on surface water (PONDS) SFY 2001. Sample results in pCi/R Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . See Figure 2 for sample locations. WCNO C sample location designations are denoted by parenthesis. *No isotopes attributable to WCNO C operations were found above method detection limits.*

Location	Date	Tritium (^3H)
P-1, New Strawn City Lake	6/25/01	<350

TABLE 5.0 Wolf Creek quarterly duplicate samples for waterborne radionuclides in ground water SFY 2001. Sample results in pCi/R Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . See Figure 2 for sample locations. WCNO C sample location designations are denoted by parenthesis. *No isotopes attributable to WCNO C operations were found above method detection limits.*

Date	J-1 (D65)	L-2 (C49)	N-1 (C10)	B-1 (B12) Control
	KDHE (WCNO C) ^a	KDHE (WCNO C)	KDHE(WCNO C)	KDHE (WCNO C)
	Tritium (^3H)			
8/17/00 9/6/00	<350 (<100) *	<350 (<100) *	* <350 (<200)	<350 (<200) *
	Gross alpha+beta			
8/17/00 9/6/00	<1 *	<1 *	* 3.2±3	<1 *

^a WCNO C results for tritium only.

TABLE 6.0 Wolf Creek ingestion pathway quarterly samples for waterborne radionuclides in drinking water SFY 2001. Sample results in pCi/R. Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . See Figure 2 for sample locations. WCNOG sample location designations are denoted by parenthesis. *No isotopes attributable to WCNOG operations were found above method detection limits.*

Date	Gross beta	Tritium (^3H)
Composite collected at LeRoy (150 mRevery 12 h) for monthly analysis ^a		
	KDHE (WCNOG)	KDHE (WCNOG)
07/26/00 (08/04/00)	(5.9 \pm 2.2)	<350
08/31/00 (09/06/00)	(7.8 \pm 2.5)	<350
09/28/00 (10/04/00)	(7.5 \pm 2.4)	<350 (<167)
10/26/00 (11/01/00)	(5.9 \pm 1.1)	<350
11/30/00 (12/06/00)	(2.4 \pm 1.7)	<350
12/28/00 (01/04/01)	(5.4 \pm 1.3)	<350
01/25/01 (02/07/01)	(4.4 \pm 1.8)	<350
02/22/01 (03/07/01)	(4.1 \pm 1.1)	<350 (<183)
03/29/01	*	<350
04/26/01 (05/02/01)	(3.6 \pm 1.2)	<350
05/24/01 (06/08/01)	(3.5 \pm 1)	<350 (<172)
06/29/01	*	<350
Burlington (BW15) ^b		
Public water supply collected at Burlington, KS (WCNOG reporting only)		
	WCNOG	WCNOG
08/04/00	7.5 \pm 2.5	*
09/06/00	6.3 \pm 2.4	*
10/04/00	8.5 \pm 2.6	<167
11/01/00	5.3 \pm 1	*
12/06/00	4.8 \pm 1.8	*
01/04/01	5 \pm 1.2	*
02/07/01	4.7 \pm 1.1	*
03/07/01	3.5 \pm 1.1	<183
*	*	*
05/02/01	3.8 \pm 1.2	*
06/08/01	4 \pm 1	<172

^a Annual composite strontium analysis showed <1 pCi/R ^{89}Sr and <1 pCi/R ^{90}Sr . The isotopes ^{89}Sr and ^{90}Sr are beta emitters. This site is collocated with WCNOG. The WCNOG water sampler is set at a nominal compositing rate of 10 mRevery hour for monthly collection and analysis of gross beta and quarterly analysis of a composite of three monthly samples for tritium.

^b This site is sampled WCNOG. WCNOG has a composite water sampler at this location.

TABLE 7.0 Wolf Creek ingestion pathway samples for radionuclide bio-accumulation in milk (from airborne radionuclide deposition on pasturage with subsequent ingestion by milk producing cattle) SFY 2001. Sample is collected at Lebo, R-1. Lebo is a control location. Sample results in pCi/R. Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . See Figure 1 for sample location. *No isotopes attributable to WCNO operations were found above method detection limits.*

Date	^{40}K , natural KDHE (WCNO)
Lebo R-1 quarterly sample collection	
19-Jul-00	1452 ± 145
05-Oct-00	1310 ± 44
28-Dec-00	1420 ± 146
19-Apr-01	1462 ± 142

^a Annual strontium analysis showed <2 pCi/R ^{89}Sr and <2 pCi/R ^{90}Sr . The isotopes ^{89}Sr and ^{90}Sr are beta emitters.

TABLE 8.0 Wolf Creek annual samples for airborne radionuclide deposition on soil SFY 2001. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. The presence of ¹³⁷Cs is not attributable to Wolf Creek operation unless accompanied by other reactor nuclides. Gamma emitting radionuclides routinely analyzed for include ⁷Be, ⁴⁰K, ⁵¹Cr, ⁵⁴Mn, ⁵⁸Co, ⁵⁹Fe, ⁶⁰Co, ⁶⁵Zn, ⁶⁷Ga, ⁹⁵Nb, ⁹⁵Zr, ⁹⁹Mo, ^{99m}Tc, ¹⁰³Ru, ¹⁰⁶Ru, ^{110m}Ag, ¹¹¹In, ¹²³I, ¹²⁵Sb, ¹³¹I, ¹³⁴Cs, ¹³⁷Cs, ¹⁴⁰Ba, ¹⁴⁰La, ¹⁴¹Ce, ¹⁴⁴Ce, ¹⁶⁹Yb, ²²⁶Ra, ²²⁸Ac, ²²⁸Th, ²³⁴Th, and ²³⁹Np. The isotopes ⁸⁹Sr and ⁹⁰Sr are beta emitters. Strontium analysis is done on selected samples. The symbol Ū indicates naturally occurring radioisotopes. See Figure 1 for sample location. WCNOG sample location designations are denoted by parenthesis. *No isotopes attributable to WCNOG operations were found above method detection limits.*

Isotope	A-1 Sector A, Sharpe KDHE 22-May-01 0.5 m ²	E-1 Scott Valley Church Control 25-Jun-01 0.25 m ²	H-1 East of CCL ^a dam, near WCA H-1 28-Jun-01 0.5 m ²
²²⁸ AcŪ	1485 ±97	1400 ±94	1529 ±100
⁷ BeŪ	<346	631 ±71	<346
¹³⁷ Cs	<80	731 ±54	229 ±18
⁴⁰ KŪ	9554 ±884	14130 ±1135	12653 ±1020
²²⁶ RaŪ	2506 ±279	3374 ±348	3517 ±356
²²⁸ ThŪ	2643 ±42408	2995 ±37432	30995 ±38689
Isotope	P-1 (MUDS) CCL public access area for fishing 25-Jun-01 0.25 m ² KDHE (WCNOG)	R-1 (EEA) CCL environmental education area 22-May-01 0.5 m ² KDHE(WCNOG)	
²²⁸ AcŪ	1230±72 (not reported)	1251 ±86 (not reported)	
⁷ BeŪ	558±51(not reported)	<346 (not reported)	
¹³⁷ Cs	325 ±22 (296 ±38)	115 ±11 (127 ±33)	
⁴⁰ KŪ	11344 ±785 (10912 ±668)	11733 ±960 (9578 ±662)	
²²⁶ RaŪ	2735 ±224 (not reported)	2783 ±300 (not reported)	
²²⁸ ThŪ	2578±32223 (not reported)	2648 ±33096 (not reported)	

^a Coffey County Lake.

TABLE 8.1 Wolf Creek random samples for airborne radionuclide deposition in soil SFY 2001. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include ⁷Be, ⁴⁰K, ⁵¹Cr, ⁵⁴Mn, ⁵⁸Co, ⁵⁹Fe, ⁶⁰Co, ⁶⁵Zn, ⁶⁷Ga, ⁹⁵Nb, ⁹⁵Zr, ⁹⁹Mo, ^{99m}Tc, ¹⁰³Ru, ¹⁰⁶Ru, ^{110m}Ag, ¹¹¹In, ¹²³I, ¹²⁵Sb, ¹³¹I, ¹³⁴Cs, ¹³⁷Cs, ¹⁴⁰Ba, ¹⁴⁰La, ¹⁴¹Ce, ¹⁴⁴Ce, ¹⁶⁹Yb, ²²⁶Ra, ²²⁸Ac, ²²⁸Th, ²³⁴Th, and ²³⁹Np. The isotopes ⁸⁹Sr and ⁹⁰Sr are beta emitters. This table reports only ¹³⁷Cs and ⁴⁰K activity. *No isotopes attributable to WCNOG operations were found above method detection limits.*

Location		Date	Isotope	
			¹³⁷ Cs	⁴⁰ K
WCRS-1-A-359-19	Melvern Lake Camping Area	02-May-01	<49	13766 ±1095
WCRS-2-A-350-11.6	State Forward Staging Area	02-May-01	508 ±37	17699 ±1385
WCRS-3-B-025-11.2	Waverly, south	02-May-01	298 ±23	16280 ±1281
WCRS-4-R-323-13.1	Pasture .25 mile N. of Linsey Dairy	04-May-01	429 ±32	15402 ±1208
WCRS-5-R-333-5.0	Pasture West of Coffey Co Airport	02-May-01	294 ±23	14303 ±1148
WCRS-6-A-012-7.7	22nd Rd., between Reaper and Planter Rd.	12-Jul-01	270 ±18	12848 ±889
WCRS-7-R-337-8	22nd Rd. & Lynx Rd.	12-Jul-01	70 ±8	15618 ±1355
WCRS-8-Q-312-11.3	22nd Rd. 1/4 mile west of Garner Rd.	12-Jul-01	356 ±27	13682 ±1095
WCRS-9-P-297-16	Angus Rd, North of Flint Hills National Wildlife Area	12-Jul-01	200 ±16	16485 ±1387
WCRS-10-P-293-12.9	19th Ln at Troublesome Creek bridge	12-Jul-01	241 ±19	20662 ±1631
WCRS-11-Q-314-5.8	Kafir Rd. at pasture gate	12-Jul-01	384 ±29	11149 ±983
WCRS-12-Q-311-3.7	17th Rd. & US 75	12-Jul-01	<49	12717 ±877
WCRS-13-A-353-0.8	Stringtown Cemetery	12-Jul-01	146 ±12	10978 ±882
WCRS-14-C-041-1.9	16th Rd, between Planter and Quail	12-Jul-01	159 ±13	8462 ±686
WCRS-15-C-042-8.7	Soybean field, Underwood Rd. 1 mile south of 22nd Rd.	17-Jul-01	202 ±16	10031 ±878
WCRS-16-C-040-7.1	Soybean field, 20th Rd. 0.2 mile west of Trefoil Rd.	17-Jul-01	183 ±13	12083 ±833
WCRS-17-C-037-5.5	Corn Filed, 19th d., ½ mile west of Shetland Rd.	17-Jul-01	172 ±14	10939 ±885
WCRS-18-N-260-5.1	JRR, Otter Creek Rec. Area	17-Jul-01	19.5 ±3.6	13904 ±962

Note: ²²⁶Ra activity average (± 1 F) was 2931 ±643 pCi/kg-dry.

TABLE 9.0 Wolf Creek annual samples for waterborne radioisotope concentration in bottom sediments SFY 2001. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include ⁷Be, ⁴⁰K, ⁵¹Cr, ⁵⁴Mn, ⁵⁸Co, ⁵⁹Fe, ⁶⁰Co, ⁶⁵Zn, ⁶⁷Ga, ⁹⁵Nb, ⁹⁵Zr, ⁹⁹Mo, ^{99m}Tc, ¹⁰³Ru, ¹⁰⁶Ru, ^{110m}Ag, ¹¹¹In, ¹²³I, ¹²⁵Sb, ¹³¹I, ¹³⁴Cs, ¹³⁷Cs, ¹⁴⁰Ba, ¹⁴⁰La, ¹⁴¹Ce, ¹⁴⁴Ce, ¹⁶⁹Yb, ²²⁶Ra, ²²⁸Ac, ²²⁸Th, ²³⁴Th, and ²³⁹Np. The isotopes ⁸⁹Sr and ⁹⁰Sr are beta emitters. Strontium analysis is done on selected samples. The symbol U indicates naturally occurring radioisotopes. See Figure 1 for sample location. WCNOC sample location designations are denoted by parenthesis.

Isotope	J-1 Wolf Creek below CCL spillway	N-1 (JRR) John Redmond Reservoir Control
	12-Apr-01 KDHE	14-Nov-00 KDHE (WCNOC)
²²⁸ AcU	1466 ±96	1273 ±98 (not reported)
¹³⁷ Cs	56±7	79 ±13 (95 ±30)
⁴⁰ KU	13002 ±1173	13705 ±1010 (13210±751)
²²⁶ RaU	2634 ±30	2409 ±416 (not reported)
²²⁸ ThU	1553 ±34898	1969±31305 (not reported)
Isotope	Q-1 (DC) CCL discharge cove	
	14-Nov-01 KDHE (WCNOC)	
²²⁸ AcU	1316 ±100 (not reported)	
⁶⁰ Co	465 ±26 (606 ±47)	
¹³⁴ Cs	<44 (98±35)	
¹³⁷ Cs	299 ±26 (351 ±50)	
⁴⁰ KU	12410 ±931 (14662 ±865)	
²²⁶ RaU	2605 ±430 (not reported)	
⁸⁹ Sr	<200 (not analyzed)	
⁹⁰ Sr	200 ±100 (not analyzed)	
²²⁸ ThU	2133 ±33323 (not reported)	

TABLE 9.1 Wolf Creek random samples for waterborne radioisotope concentration in bottom sediments SFY 2001. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include ⁷Be, ⁴⁰K, ⁵¹Cr, ⁵⁴Mn, ⁵⁸Co, ⁵⁹Fe, ⁶⁰Co, ⁶⁵Zn, ⁶⁷Ga, ⁹⁵Nb, ⁹⁵Zr, ⁹⁹Mo, ^{99m}Tc, ¹⁰³Ru, ¹⁰⁶Ru, ^{110m}Ag, ¹¹¹In, ¹²³I, ¹²⁵Sb, ¹³¹I, ¹³⁴Cs, ¹³⁷Cs, ¹⁴⁰Ba, ¹⁴⁰La, ¹⁴¹Ce, ¹⁴⁴Ce, ¹⁶⁹Yb, ²²⁶Ra, ²²⁸Ac, ²²⁸Th, ²³⁴Th, and ²³⁹Np. The isotopes ⁸⁹Sr and ⁹⁰Sr are beta emitters. This table reports only ¹³⁷Cs and ⁶⁰Co activity. Strontium analysis is done on selected samples.

	Location	Date	Isotope	
			¹³⁷ Cs	⁶⁰ Co
WCRBS-1-Q-316-0.4	CCL Discharge Cove Boat Ramp	13-Sep-00	53 ±7	121 ±8
WCRBS-2-Q-305-0.8	Entrance to North Discharge Cove	13-Sep-00	254 ±22	343 ±17
WCRBS-3-R-329-1.0	CCL North cove ENE of Stringtown Cemetary	13-Sep-00	311 ±28	688 ±35
WCRBS-4-R-342-1.2	CCL North cove NNE of Stringtown Cemetary	13-Sep-00	97 ±10	125 ±8
WCRBS-5-R-334-0.7	NE Cove south of Stringtown Cemetery	13-Sep-00	220 ±20	416 ±22
WCRBS-6-A-351-0.7	NE Cove southeast of Stringtown Cemetery	13-Sep-00	91 ±9	103 ±7
WCRBS-7-P-300-1.1	Discharge Cove entrance	13-Sep-00	301 ±26	446 ±22
WCRBS-8-Q-308-1.4	CCL Main Lake, 0.3 mi NNE of Baffle Dike	13-Sep-00	194 ±18	229 ±13
WCRBS-9-Q-317-1.5	CCL Main Lake, 4th cove north of Baffle Dike B	13-Sep-00	87 ±10	78 ±7
WCRBS-10-Q-324-1.8	CCL Main Lake, 5th cove north of Baffle Dike B	13-Sep-00	90 ±10	78 ±7
WCRBS-11-R-329-2.5	CCL Main Lake, 0.3 mi south of 17 th Rd. Causeway	13-Sep-00	144 ±13	109 ±6
WCRBS-12-Q-324-2.4	CCL Main Lake, 0.5 mi south of 17 th Rd. Causeway	13-Sep-00	111 ±11	62 ±5
WCRBS-13-C-037-5.5	Long Creek, 19th Rd Crossing, 1/2 mile west of Shetland Rd.	17-Jul-01	<49	<56
WCRBS-14-A-350-4.5	Wolf Creek, 19th Rd crossing, 0.6 mile west of Oxen Rd.	17-Jul-01	70 ±8	<56
WCRBS-15-P-292-11	Laird Pond, FHNWA ^a	17-Jul-01	164 ±12	<56

^a Flint Hills National Wildlife Area.

Notes:

- Seven samples showed Strontium activity (Noted in **Bold**). Maximum ⁸⁹Sr activity was 900 ±700 pCi/kg (mean activity was 500±375 pCi/kg) and maximum ⁹⁰Sr activity was 200±100 pCi/kg (mean activity was 200±100 pCi/kg).
- Samples WCRBS-1 through 12 were all taken on Coffey County lake.
- All samples showed ⁴⁰K and ²²⁶Ra activity (naturally occurring) above LLD. Average ⁴⁰K activity was 10,783 ± 1,011 pCi/kg. Average ²²⁶Ra activity was 2,866 ± 510 pCi/kg.

TABLE 10.0 Wolf Creek annual samples for waterborne radioisotope concentration in shoreline sediment SFY 2001. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include ⁷Be, ⁴⁰K, ⁵¹Cr, ⁵⁴Mn, ⁵⁸Co, ⁵⁹Fe, ⁶⁰Co, ⁶⁵Zn, ⁶⁷Ga, ⁹⁵Nb, ⁹⁵Zr, ⁹⁹Mo, ^{99m}Tc, ¹⁰³Ru, ¹⁰⁶Ru, ^{110m}Ag, ¹¹¹In, ¹²³I, ¹²⁵Sb, ¹³¹I, ¹³⁴Cs, ¹³⁷Cs, ¹⁴⁰Ba, ¹⁴⁰La, ¹⁴¹Ce, ¹⁴⁴Ce, ¹⁶⁹Yb, ²²⁶Ra, ²²⁸Ac, ²²⁸Th, ²³⁴Th, and ²³⁹Np. The isotopes ⁸⁹Sr and ⁹⁰Sr are beta emitters. Strontium analysis is done on selected samples. The symbol Ū indicates naturally occurring radioisotopes. See Figure 1 for sample location. WCNO sample location designations denoted by parenthesis.

Isotope	N-1 (JRR) John Redmond Reservoir Control	P-1 (MUDS) CCL public access area for fishing	Q-1 (DC) CCL discharge cove
	14-Nov-00 KDHE (WCNO)	25-Jun-01 KDHE (WCNO)	14-Nov-00 KDHE (WCNO)
²²⁸ AcŪ	1704 ±124 (not reported)	1306 ±85 (not reported)	1569 ±117 (not reported)
⁷ BeŪ	<346	<346 (not reported)	1288 ±206 (not reported)
¹³⁷ Cs	<80 (<14)	80 (<24)	93 ±11 (67 ±16)
⁶⁰ Co	<56 (<13)	<56 (<17)	56 ±7 (52 ±14)
⁴⁰ KŪ	13377 ±1037 (11831 ±340)	8672 ±704 (9376 ±546)	12815 ±1007 (9466 ±330)
²²⁶ Ra	3446 ±631 (not reported)	2970 ±312 (not reported)	3827 ±694 (not reported)
⁸⁹ Sr	not analyzed	not analyzed	<200 (not analyzed)
⁹⁰ Sr	not analyzed	not analyzed	200 ±100 (not analyzed)
²²⁸ Th	2921 ±36514 (not reported)	2668 ±33350 (Not reported)	2980 ±37253 (not reported)

TABLE 10.1 Wolf Creek random samples for waterborne radioisotope concentration in shoreline sediments SFY 2001. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include ⁷Be, ⁴⁰K, ⁵¹Cr, ⁵⁴Mn, ⁵⁸Co, ⁵⁹Fe, ⁶⁰Co, ⁶⁵Zn, ⁶⁷Ga, ⁹⁵Nb, ⁹⁵Zr, ⁹⁹Mo, ^{99m}Tc, ¹⁰³Ru, ¹⁰⁶Ru, ^{110m}Ag, ¹¹¹In, ¹²³I, ¹²⁵Sb, ¹³¹I, ¹³⁴Cs, ¹³⁷Cs, ¹⁴⁰Ba, ¹⁴⁰La, ¹⁴¹Ce, ¹⁴⁴Ce, ¹⁶⁹Yb, ²²⁶Ra, ²²⁸Ac, ²²⁸Th, ²³⁴Th, and ²³⁹Np. The isotopes ⁸⁹Sr and ⁹⁰Sr are beta emitters. This table reports only ¹³⁷Cs and ⁶⁰Co activity. Strontium analysis is done on selected samples.

	Location	Date	Isotope	
			¹³⁷ Cs	⁶⁰ Co
WCRSS-1-Q-318-0.4	Discharge Cove Boat Ramp	13-Sep-00	60 ±8	<56
WCRSS-2-P-301-0.8	West shore of North Discharge Cove entrance	13-Sep-00	105 ±10	<56
WCRSS-3-Q-318-1.0	North Cove, west shore near old Native road bed.	13-Sep-00	145 ±13	86 ±7
WCRSS-4-R-339-1.2	North Cove, NW Shore	13-Sep-00	164 ±17	<56
WCRSS-5-R-336-0.8	North Cove, North Shore of NE Cove entrance	13-Sep-00	<49	77 ±5
WCRSS-6-Q-325-0.6	South shore of NE cove entrance	13-Sep-00	<49	<56
WCRSS-7-P-303-0.4	Discharge Cove south of outfall	13-Sep-00	<49	143 ±11
WCRSS-8-Q-309-1.2	Main Lake, South shore of 2nd cove north of DC ^a	13-Sep-00	<49	<56
WCRSS-9-Q-318-1.6	Main Lake, North shore of 4th cove north of DC ^a	13-Sep-00	<49	<56
WCRSS-10-R-332-2.2	Main Lake, East shore of 6th cove north of DC ^a	13-Sep-00	<49	<56
WCRSS-11-Q-325-2.5	Main Lake, West shore, 0.4 mi. South of 17th Rd causeway	13-Sep-00	53 ±68	<56
WCRSS-12-Q-311-2.1	Main Lake, West shore, 1.1 mi. South of 17th Rd causeway	13-Sep-00	83 ±88	<56
WCRSS-13-N-260-5.1	JRR, Otter Creek Rec. Area, near the boat ramp	17-Jul-01	71 ±7	<56
WCRSS-14-P-297-3.4	New Strawn City Lake	17-Jul-01	<49	<56
WCRSS-15-H-159-3.6	Salava's Pond	19-Jul-01	<49	<56
WCRSS-16-P-289-15	Neosho River bank, Hartford, KS.	19-Jul-01	<49	<56
WCRSS-17-A-358-19	Melvorn Lake, Camping Area	19-Jul-01	<49	<56

^a Discharge Cove

Notes:

1. Three samples showed Strontium activity above LLD. Maximum ⁸⁹Sr activity was 200±100 pCi/kg (one sample). Maximum ⁹⁰Sr activity was 600±200 pCi/kg (mean was 433±133 pCi/kg). Sample locations are in **Bold**.
2. Samples WCRSS-1 through 12 were taken on CCL.
3. All samples showed ⁴⁰K and ²²⁶Ra activity (naturally occurring) above LLD. Average ⁴⁰K activity was 11,132±954 pCi/kg. Average ²²⁶Ra activity was 2,805±468 pCi/kg.

TABLE 11.0 Wolf Creek fish ingestion pathway duplicate samples for waterborne radioisotope bio-accumulation in fish SFY 2001. Sample results in pCi/kg-wet. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include ⁷Be, ⁴⁰K, ⁵¹Cr, ⁵⁴Mn, ⁵⁸Co, ⁵⁹Fe, ⁶⁰Co, ⁶⁵Zn, ⁶⁷Ga, ⁹⁵Nb, ⁹⁵Zr, ⁹⁹Mo, ^{99m}Tc, ¹⁰³Ru, ¹⁰⁶Ru, ^{110m}Ag, ¹¹¹In, ¹²³I, ¹²⁵Sb, ¹³¹I, ¹³⁴Cs, ¹³⁷Cs, ¹⁴⁰Ba, ¹⁴⁰La, ¹⁴¹Ce, ¹⁴⁴Ce, ¹⁶⁹Yb, ²²⁶Ra, ²²⁸Ac, ²²⁸Th, ²³⁴Th, and ²³⁹Np. A Tritium (³H) in tissue analysis is done on all edible fish portions collected. ³H is a beta emitter. See Figure 1 for sample locations. WCNOG sample location designations are denoted by parenthesis.

Location	Date	Description	Isotope	
			⁴⁰ K, natural KDHE (WCNOG)	³ H KDHE (WCNOG)
N-1 (JRR) John Redmond Reservoir below dam on Neosho River Control	07-Nov-00	Largemouth Bass (2)	3418±476 (3204 ±447)	<1200 (109±65)
		Common Carp (2)	3496 ±518 (3249 ±319)	not analyzed (94±64)
		Smallmouth Buffalo (3)	2955 ±345 (2341 ±267)	not analyzed (68±63)
	11-May-01	Largemouth Buffalo (2)	2303 ±748(2997 ±449)	not analyzed (<111)
		Common Carp (3)	4630 ±455 (3200 ±373)	not analyzed (<106)
		Channel Catfish (2)	3268 ±865 (3215 ±597)	<1200 (<113)
Q-1 (DC) CCL discharge cove ^a	14-Nov-00	Common Carp (4)	2887 ±430 (3759 ±422)	not analyzed (10362 ±255)
		White Bass (8)	3298 ±945 (3505 ±393)	not analyzed (9775 ±235)
		Largemouth Bass (5)	3946 ± 2145(3443 ±297)	9930 ±1331 (9749 ±240)
		Wiper (3)	5036±528 (4362±507)	not analyzed (10247±250)
	07-May-01	Channel Catfish (4)	3808 ±404 (2852 ±380)	not analyzed (3944 ±119)
		Common Carp (3)	4681 ±526 (3338 ±483)	not analyzed (5492 ±154)
		Smallmouth Bass (4)	3525 ±442 (3379 ±539)	9666 ±1279 (4830 ±134)

^a Coffey County Lake.

TABLE 12.0 Wolf Creek samples for waterborne radioisotope bioaccumulation in aquatic vegetation SFY 2001. Sample results in pCi/kg-dry (KDHE) and pCi/kg-wet (WCNOC). Results reported at the 95% confidence level. *No isotopes attributable to WCNOC operations were found above method detection limits.* Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . The isotopes ^{89}Sr and ^{90}Sr are beta emitters. Strontium analysis is done on selected samples. The symbol \bar{U} indicates naturally occurring radioisotopes. See Figure 1 for sample location. WCNOC sample location designations are denoted by parenthesis.

Isotope	WCRRA-3-A-350-4.5 Wolf Creek, 19 th Rd. , 0.6 mi. west of Oxen Rd. Arrowhead (<i>Sagittaria latifolia</i>) 17-Jul-01	WCRRA-4-P-292-11 Laird Pond, Flint Hills National Wildlife Area Composite (<i>American Lotus (Nymphaeaceae)</i> , <i>Water Primrose</i> , <i>Pond Weed</i>) 17-Jul-01
$^7\text{Be}\bar{U}$ ^{137}Cs $^{40}\text{K}\bar{U}$ $^{226}\text{Ra}\bar{U}$ $^{228}\text{Th}\bar{U}$	1232 ±141 <80 33711 ±2427 1275±331 1539±19246 WET/DRY = 5.8	2167 ±219 127±17 16278 ±1183 1943 ±283 1673 ±20917 WET/DRY = 8.2
Isotope	WCRRA-2-R-334-2.1 (DC) CCL NE Pond Weed 6 th Cove north of Baffle Dike B, east side 13-Sep-00 KDHE (WCNOC) ^a	WCRRA-5-H-159-3.6 Salava's Pond Composite (<i>American Lotus (Nymphaeaceae)</i> , <i>Water Primrose</i> , <i>Pond Weed</i>) 19-Jul-01 KDHE
$^{228}\text{Ac}\bar{U}$ $^7\text{Be}\bar{U}$ ^{137}Cs $^{40}\text{K}\bar{U}$ $^{226}\text{Ra}\bar{U}$ $^{228}\text{Th}\bar{U}$	415 ±90 (not reported) 612 ±104 (152 ±85) <80 (5.5 ±3.8) 8941 ±1653 (2830 ±175) 1154 ±408 (43 ±9) 1068 ±35320 (64 ±8) WET/DRY =4.4	599 ±199 6633 ±635 <80 24738 ±3391 1106 ±536 1275 ±83076 WET/DRY = 10.7
Isotope	WCRRA-1-Q-318-1.6 (Q-1) (DC) CCL discharge cove 13-Sep-00 KDHE (WCNOC) ^b <i>American Lotus (Nymphaeaceae)</i>	R-1 (EEA) CCL environmental education area 22-May-01 KDHE <i>Algae</i>
$^{228}\text{Ac}\bar{U}$ $^7\text{Be}\bar{U}$ ^{137}Cs $^{40}\text{K}\bar{U}$ $^{226}\text{Ra}\bar{U}$ $^{228}\text{Th}\bar{U}$	551±54 (not reported) 1910 ±217 (271± 102) <80 (6±3) 10970 ±845 (2170±172) 1166 ±343 (not reported) 1186 ±14832 (54 ±9) WET/DRY = 4.4	1275 ±117 2449 ±240 <80 16742 ±1401 2245 ±394 1891 ±23643 WET/DRY = 5.5

^a WCNOC also reported ^{141}Ce (43 ± 35 pCi/kg-wet) and ^{235}U (16 ±6 pCi/kg-wet).

^b WCNOC also reported ^{235}U (14 ±7 pCi/kg-wet).

TABLE 13.0 Wolf Creek trending samples for airborne radionuclide deposition on terrestrial vegetation SFY 2001. Includes ingestion pathway sampling of garden vegetables and sampling for waterborne radionuclide bio-accumulation in irrigated crops. Sample results in pCi/kg-dry (KDHE) and pCi/kg-wet (WCNOC). Results reported at the 95% confidence level. *No isotopes attributable to WCNOC operations were found above method detection limits.* Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . The isotopes ^{89}Sr and ^{90}Sr are beta emitters. Strontium analysis is done on selected samples. See Figure 1 for sample location. WCNOC sample location designations are denoted by parenthesis.

Location	Date	Description	Isotope	
			^7Be natural KDHE (WCNOC)	^{40}K natural KDHE (WCNOC)
A-1 Sector A, Sharpe/Pasture near Sharpe	22-May-01	Pasturage, 1.0 m ² Wet/Dry = 3.0	4107 ±216	11276 ±599
E-1 Scott Valley Church Control	25-Jun-01	Pasturage, 2.0 m ² Wet /Dry = 2.5	6287 ±604	14351 ±2826
E-2 Garden in Sector E	26-Jul-00	Squash leaves, 1.0 m ² Wet/Dry = 5.9	9805±1261 (1530 ±113)	24626 ±2443 (3530 ±275)
F-1 Finical's Garden (Garden Sector F)	26-Jul-00	Horseradish Leaves, 2.5 m ² Wet/Dry = 4.6	2366±304 (623±105)	20800±1708 (4730±470)
H-1 East of CCL dam, near WCA H-1	28-Jun-01	Pasturage, 1.5 m ² Wet/Dry = 2.5	7079 ±580	14373 ±1296
J-1 (NR-D1) Near LeRoy, crops that may be irrigated with water from the Neosho River below the confluence with Wolf Creek	04-Oct-00	Soybeans (Non-irrigated) Collected by WCNOC	<35 (<729)	13927±1105 (18012± 818)
J-2 (NR-D2) Near LeRoy, crops that may be irrigated with water from the Neosho River below the confluence with Wolf Creek	4-Oct-00	Soybeans (Irrigated) Collected by WCNOC	<35 (<763)	19431±1560 (17678±906)
K-1 (NR-U1) Control, near Burlington, crops irrigated with water from the Neosho River above the confluence with Wolf Creek	27-Sep-00	Corn (irrigated) Soybeans (irrigated) Collected by WCNOC	<35 (<386) <35 (<410)	3057±289 (3820 ±298) 14386±1827 (18800±770)
P-1 (MUDS) CCL public access area, north side of parking lot, 10 m from shore	25-Jun-01	Pasturage, 1.5 m ² WET/DRY = 3.4	5235 ±422 (2371 ±530)	13356±1078 (5442 ±775)
R-1 (EEA) CCL environmental education area	22-May-01	Pasturage, 1.0 m ² WET/DRY = 3.3	1153 ±172 (529 ±287)	22525 ±1471 (6613 ±770)

TABLE 13.1 Wolf Creek random samples for airborne radionuclide deposition on terrestrial vegetation SFY 2001. Includes ingestion pathway sampling of garden vegetables. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. *No isotopes attributable to WCNO operations were found above method detection limits.* Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . The isotopes ^{89}Sr and ^{90}Sr are beta emitters. Strontium analysis is done on selected samples. See Figure 5 for sample location. WCNO sample location designations are denoted by parenthesis.

	Location	Date	Description	Isotope	
				^7Be	^{40}K
WCRFV-01-A-354-1.1	Field North of Stringtown Cemetery	07-Sep-00	Dry corn	<86	3046 ±554
WCRFV-02-A-354-1.1	Field North of Stringtown Cemetery	07-Sep-00	Silage ^b	818 ±137	6749 ±731
WCRFV-03-A-358-19.1	Melvorn Lake Park	02-May-01	Pasturage	3651 ±315	26773 ±2211
WCRFV-04-A-350-11.6	State Forward Staging Area	02-May-01	Pasturage	6101 ±546	13112 ±1317
WCRFV-05-B-025-11.2	Waverly, South	02-May-01	Pasturage	2466 ±240	26176 ±1836
WCRFV-06-R-333-5	Field West of Coffey County Airport	02-May-01	Pasturage	1384 ±191	39415 ±3346
WCRFV-07-R-323-13.5	Pasture near Linsey Dairy	04-May-01	Pasturage	2440 ±299	24506 ±1928
WCRFV-08-B-017-2.53	Field, South side of 17th Rd. 1/4 mile from Oxen Rd	14-Jun-01	Wheat, raw	3179 ±298	9220 ±940
WCRFV-09-D-071-3.46	Field, west side of Shetland Rd, 1/4 mile south of 16th Rd.	14-Jun-01	Wheat, raw	2075 ±207	6006 ±632
WCRFV-10-A-012-7.7	22nd Rd., between Reaper and Planter Rd.	12-Jul-01	Pasturage	5057 ±440	15931 ±2032
WCRFV-11-R-337-8	22nd Rd. & Lynx Rd.	12-Jul-01	Pasturage	7317 ±596	11528 ±1051
WCRFV-12-Q-312-11.3	22nd Rd. 1/4 mile west of Garner Rd.	12-Jul-01	Pasturage	6971 ±555	14664 ±1205
WCRFV-13-P-297-16	Angus Rd, North entry to FHNWA ^a	12-Jul-01	Pasturage	6124 ±476	8797 ±752
WCRFV-14-P-293-12.9	19th Ln at Troublesome Creek bridge	12-Jul-01	Pasturage	5557 ±500	32946 ±3493
WCRFV-15-Q-314-5.8	Kafir Rd. by pasture gate	12-Jul-01	Pasturage	4701 ±433	10965 ±1095
WCFV-16-Q-311-3.7	17th Rd. & US 75	12-Jul-01	Pasturage	4358 ±490	14635 ±2881
WCRFV-17-C-041-1.9	16th Rd. between Planter and Quail	12-Jul-01	Pasturage	4664 ±450	9660 ±1035
WCRFV-18-R-343-.83	Stringtown Cemetery	28-Jun-01	Red Sumac ^c	2590 ±236	9473 ±810
WCRFV-19-260-5.1	Otter Creek Recreation Area, JRR	17-Jul-01	Sunflowers	2079 ±186	11604 ±1273

^a Flint Hills National Wildlife Area

^b Corn husks, stalks and cobs.

^c *Rhus glabra*

TABLE 14.0 KDHE radiochemistry laboratory Intercomparison studies SFY 2001. Data in pCi/R ^a

Date	Analysis	Control		Control limit	KDHE	
		Known value	Expected precision		Mean	Standard error of the mean
Gross alpha and beta in water						
26-Jul-00	Gross alpha	7.17	± 5.0	± 8.7	5.1	± 0.7
	Gross beta	87.5	± 10	± 17.4	74.0	± 2.9
20-Oct-00	Gross alpha	74.4	± 18.6	± 32.7	72.3	± 1.6
	Gross beta	256.0	± 38.4	± 66.9	233.0	± 5.5
1-Nov-00	Gross alpha	60.3	± 15.1	± 25.8	54.2	± 3.7
	Gross beta	25.5	± 5.0	± 8.7	25.7	± 0.7
18-Apr-01	Gross alpha	56.0	± 14.0	± 24.2	49.7	± 1.7
	Gross beta	340	± 51.0	± 88.0	342	± 8.5
Strontium in water						
12-Jul-00	⁸⁹ Sr	62.2	±5.0	±8.7	56.5	±1.6
	⁹⁰ Sr	26.2	±5.0	±8.7	25.7	±1.1
20-Oct-00	⁸⁹ Sr	41.3	±5.0	±8.7	38.4	±1.5
	⁹⁰ Sr	18.0	±5.0	±8.7	19.3	±0.6
10-Jan-01	⁸⁹ Sr	11.1	±5.0	±8.7	8.6	±0.6
	⁹⁰ Sr	7.9	±5.0	±8.7	8.2	±1.0
18-Apr-01	⁸⁹ Sr	64.1	±5.0	±8.7	55.9	±1.0
	⁹⁰ Sr	33.8	±5.0	±8.7	37.0	±1.0
Iodine in water						
2-Oct-00	¹³¹ I	15.9	±3.0	±5.2	16.0	±0.2
8-Feb-01	¹³¹ I	28.3	±3.0	±5.2	26.6	±1.3
Gamma in water						
20-Oct-00	⁶⁰ Co	91.1	±5.0	±8.7	97.0	±2.6
	¹³⁴ Cs	59.8	±5.0	±8.7	60.7	±0.6
	¹³⁷ Cs	45.0	±5.0	±8.7	47.3	±0.6
8-Nov-00	⁶⁰ Co	27.8	±5.0	±8.7	29.7	±0.6
	⁶⁵ Zn	79.0	±7.9	±13.8	80.7	±3.5
	¹³⁴ Cs	76.0	±5.0	±8.7	75.7	±0.6
	¹³⁷ Cs	106	±5.3	±8.7	107	±5.3
	¹³³ Ba	82.2	±8.2	±14.2	79.3	±1.5
18-Apr-01	⁶⁰ Co	26.4	±5.0	±8.7	28.1	±1.5
	¹³⁴ Cs	16.9	±5.0	±8.7	17.3	±0.6
	¹³⁷ Cs	186.0	±9.3	±16	187	±2.5
6-Jun-01	⁶⁰ Co	46.8	±5.0	±8.7	48.9	±3.0
	⁶⁵ Zn	36.2	±5.0	±8.7	38.0	±2.6
	¹³⁴ Cs	15.9	±5.0	±8.7	15.3	±0.3
	¹³⁷ Cs	197.0	±9.9	±17	206.0	±3.8
	¹³³ Ba	36.0	±5.0	±8.7	35.4	±0.7
Tritium in water						
3-Aug-00	³ H	8320	±832	±1280	840017300	±36
8-Feb-01	³ H	17800	±1780	±2100		±79

^a Intercomparison samples were purchased from Environmental Resource Associates

Performance analyses were also done for ²²⁶Ra, ²²⁸Ra, and uranium in water (public water supply). These results are not presented.

TABLE 15.0 KDHE radiochemistry laboratory method detection limits SFY 2001. Listed below are method detection limits of present analytical methods for some of the radionuclides monitored by the Radiochemistry Laboratory of KDHE. These limits are intended as guides to order of magnitude sensitivities and are calculated with a 95% level of confidence (activity will be detected 95% of the time if it is present).

GeLi [HPGe] detection system ^a						
Environmental sampling						
	Water and milk	Filter	Wipe	Soil and sediment	Biota	Vegetation and food products
Minimum sample size	2000 mR	1500 m ³	Total	0.45 kg	0.3 kg	1 kg
Minimum counting time	8 hr	3 hr	3 hr	15 hr	15 hr	15 hr
Method detection limit	pCi/R	pCi/m ³	pCi/wipe	pCi/kg-dry	pCi/kg-wet	pCi/kg-dry
⁷ Be	64 [22]	0.03 [0.02]	****	346 [186]	231 [144]	35 [19]
⁴⁰ K	88 [39]	0.03 [0.02]	****	828 [654]	459 [262]	152 [72]
⁵¹ Cr	52 [32]	0.01 [0.009]	5 [3]	35 [22]	41 [32]	55 [46]
⁵⁴ Mn	4 [2]	0.004 [0.003]	1 [0.7]	44 [11]	30 [15]	72 [24]
⁵⁸ Co	4 [2]	0.008 [0.002]	2 [1]	45 [23]	37 [20]	92 [36]
⁵⁹ Fe	8 [3]	0.01 [0.01]	3 [2]	51 [16]	41 [15]	97 [52]
⁶⁰ Co	11 [7]	0.01 [0.0053]	2.5 [1.7]	56 [35]	43 [26]	79 [50]
⁶⁵ Zn	8 [4]	0.01 [0.007]	****	48 [30]	38 [22]	93 [63]
⁹⁵ Nb	7 [3]	0.009 [0.007]	2.5 [1.4]	68 [30]	44 [26]	9 [4]
⁹⁵ Zr	6 [3]	0.01 [0.002]	0.5 [0.3]	35 [27]	27 [19]	84 [54]
⁹⁹ Mo	5 [3]	0.002 [0.0014]	1 [0.6]	73 [43]	33 [21]	****
¹⁰³ Ru	10 [7]	0.004 [0.003]	****	29 [20]	29 [21]	69 [47]
¹⁰⁶ Ru	55 [43]	0.07 [0.05]	1.5 [1]	269 [192]	43 [29]	96 [65]
^{110m} Ag	4 [3]	0.006 [0.0002]	****	47 [33]	47 [34]	86 [55]
¹²⁵ Sb	35 [12]	0.02 [0.01]	****	97 [44]	96 [51]	15 [6]
¹³¹ I	5 [3] (1) ^b	0.00027 [0.00027] ^c	1.5 [1]	33 [20]	37 [23]	45 [13]
¹³⁴ Cs	5 [3]	0.007 [0.004]	1.4 [1]	44 [29]	37 [24]	57 [39]
¹³⁷ Cs	7 [4]	0.006 [0.004]	1 [0.3]	49 [29]	32 [21]	80 [56]
¹⁴⁰ Ba	10 [6]	0.004 [0.003]	****	26 [17]	24 [15]	60 [39]
¹⁴⁰ La	9 [5]	0.01 [0.02]	****	28 [9]	34 [21]	13 [6]
¹⁴¹ Ce	8 [3]	0.002 [0.001]	****	46 [23]	22 [13]	6 [3]
¹⁴⁴ Ce	35 [14]	0.013 [0.0096]	****	216 [103]	110 [70]	28 [14]
²²⁶ Ra	116 [69]	0.05 [0.03]	****	828 [654]	323 [195]	90 [51]
²²⁸ Ac	30 [18] 15 h	0.0127 [0.0099]	****	68 [33]	146 [87]	27 [12]
²²⁸ Th	387 [142]	0.09 [0.06]	****	859 [317]	944 [356]	454 [167]
²³⁴ Th	618 [87] 15 h	0.159 [0.0423]	****	1009 [378]	1300 [556]	570 [94]
²³⁵ U	****	****	45 [30] 15 h	****	****	****
²³⁹ Np	41 [33]	0.01 [0.009]	5 [3]	64 [44]	40 [30]	97 [71]

^a GeLi = Germanium lithium; HPGe = High purity germanium.

^b Two methods of analysis are done: **1)** 8 hour direct gamma isotopic analysis of a 2000 mRmilk or water sample that has a method detection limit (MDL) of 3 pCi/R and **2)** 3 hour gamma isotopic analysis of ion exchange resin after a 1500 mRmilk sample is filtered through an ion exchange column that has an MDL of 1 pCi/R

^c The MDL for ¹³¹I when analyzing a charcoal cartridge is 0.03 [0.02] pCi/m³ based upon a 250 m³ sample volume. If the sample volume is increased to 1500 m³, the MDL is 0.002 [0.001] pCi/m³.

TABLE 15.0, continued KDHE radiochemistry laboratory method detection limits SFY 2001. Listed below are method detection limits of present analytical methods for some of the radionuclides monitored by the Radiochemistry Laboratory of KDHE. These limits are intended as guides to order of magnitude sensitivities and are calculated with a 95% level of confidence (activity will be detected 95% of the time if it is present).

Low background alpha and beta counting system					
	Water	Milk	Wipe	Soil and sediment	Vegetation and food products
Minimum sample size	1000 mR	1000 mR	Total	0.01 kg	0.1 kg
Minimum counting time	200 min.	200 min.	200 min.	200 min.	200 min.
Method detection limit	pCi/R	pCi/R	pCi/wipe	pCi/kg-dry	pCi/kg-dry
⁸⁹ Sr	1	2	3	200	500
⁹⁰ Sr	1	2	4	200	500
¹³¹ I	1	****	****	****	****
²²⁸ Ra	1.2	****	0.3	60	****
Gross beta					
	Water		Filter		Wipe
Minimum sample size	200 mR		250 m ³		Total
Minimum counting time	200 min.		100 min.		100 min.
Method detection limit	4 pCi/R		0.004 pCi/m ³		2 pCi/wipe
Internal proportional counter					
	Water		Wipe		Soil and sediment
Minimum sample size	1000 mR		Total		0.01 kg
Minimum counting time	100 min.		200 min.		200 min.
Method detection limit	pCi/R		pCi/wipe		pCi/kg-dry
²²⁶ Ra	0.3		0.2		4
Gross alpha					
	Water	Filter	Wipe		Soil and sediment
Minimum sample size	200 mR	250 m ³	Total		0.001 kg
Minimum counting time	200 min.	100 min.	100 min.		100 min.
Method detection limit	1 pCi/R	0.0006 pCi/m ³	0.5 pCi/wipe		160 pCi/kg-dry
Random scintillation counting system					
²²⁶ Ra (radium) in water					
Minimum sample size				1000 mR	
Minimum counting time				200 min.	
Method detection limit				0.04 pCi/R	
Liquid scintillation counting system					
	³ H (tritium)		²²² Rn (radon) in water		
	In water	In tissue			
Minimum sample size	10 mR	3 g	10 mR		
Minimum counting time	100 min.	120 min.	60 min.		
Method detection limit	350 pCi/R	1200 pCi/kg-wet	25 pCi/R		

TABLE 16.0 Lower limit of detection (LLD) values for selected radionuclides for WCNOE environmental sample analysis. ^a

Analysis	Water (pCi/R)	Airborne (pCi/m ³)	Fish (pCi/kg-wet)	Milk (pCi/R)	Food Products ^b (pCi/kg-wet)	Sediment (pCi/kg-dry)	Aquatic Vegetation (pCi/kg-wet)
Gross Beta	4 (2)	0.01 (0.003)	*	*	*	*	*
³ H	2000 ^c (1000)	*	(300)	*	*	*	*
⁵⁴ Mn	15	*	130	*	(40)	(30)	(40)
⁵⁹ Fe	30	*	260	*	*	*	*
⁵⁸ Co and ⁶⁰ Co	15 (5)	*	130	*	(10)	(30)	(40)
⁶⁵ Zn	30	*	260	*	*	*	(10)
⁹⁵ Zr and ⁹⁵ Nb	15	*	*	*	(10)	*	(40)
¹³¹ I	1 ^d (0.5)	0.07 (0.007)	*	1 (0.3)	60	*	*
¹³⁴ Cs	15	0.05	130	15	60	150 (60)	(20)
¹³⁷ Cs	18	0.06	150	18	80 (10)	180 (60)	(10)
¹⁴⁰ Ba and ¹⁴⁰ La	15	*	*	15	*	*	*
⁵¹ Cr	*	*	*	*	*	*	(500)
¹²⁵ Sb	*	*	*	*	*	*	(50)
²²⁶ Ra	*	*	*	*	(200)	(500)	(200)
²²⁸ Th	*	*	*	*	(20)	(40)	(20)
⁷ Be	*	(0.001)	*	*	(100)	(300)	(100)
⁴⁰ K	*	(0.002)	(500)	(100)	(500)	(500)	(500)

^a This table is adapted from Table 5-3 of WCNOE's Offsite Dose Calculation Manual (ODCM). Values in parenthesis reflect typical LLDs achievable by offsite laboratories. This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported. The LLD is defined as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95 percent probability with only 5 percent probability of falsely concluding that a blank observation represents a "real" signal. For a particular measurement system, which may include radio-chemical separation:

$$LLD = 2.10 \times \left[\frac{S_b}{EY \exp(-\lambda \Delta t)} \right]$$

Where LLD is the *a priori* lower limit of detection (picoCuries per Unit mass or Volume), S_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute), E is the counting efficiency (counts per disintegration), V is the sample size (units of mass or volume), 2.10 is a conversion factor with units picoCurie per disintegration per minute (4.66/2.22 dpm/pCi), Y is the fractional radiochemical yield (when applicable), λ is the radioactive decay constant for the particular radionuclide (s^{-1}), and t is the elapsed time between sample collection (or end of the sample collection period), and time of counting (s).

It should be recognized that the LLD is defined as an *a priori* (before the fact) limit representing the capability of a measurement system and not used as an *a posteriori* (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described.

^b Includes terrestrial vegetation.

^c LLD for drinking water samples. If no drinking water pathway exists, a value of 3000 pCi/R may be used.

^d LLD for drinking water samples. If no drinking water pathway exists, the LLD of gamma isotopic analysis may be used.

Note: If the above equation is used with an actual background count of a sample and a recently determined counting efficiency (using *a posteriori* values instead of assumed *a priori* values), the minimum detectable activity (MDA) may be calculated. Ideally, the MDA will be very close to the LLD. The LLD is a device to predict the detection capability of the counting system, while the MDA reflects the actual detection capability of a counting system. An MDA should be determined for each sample analyzed. The method detection limit (MDL) and MDA are equivalent.

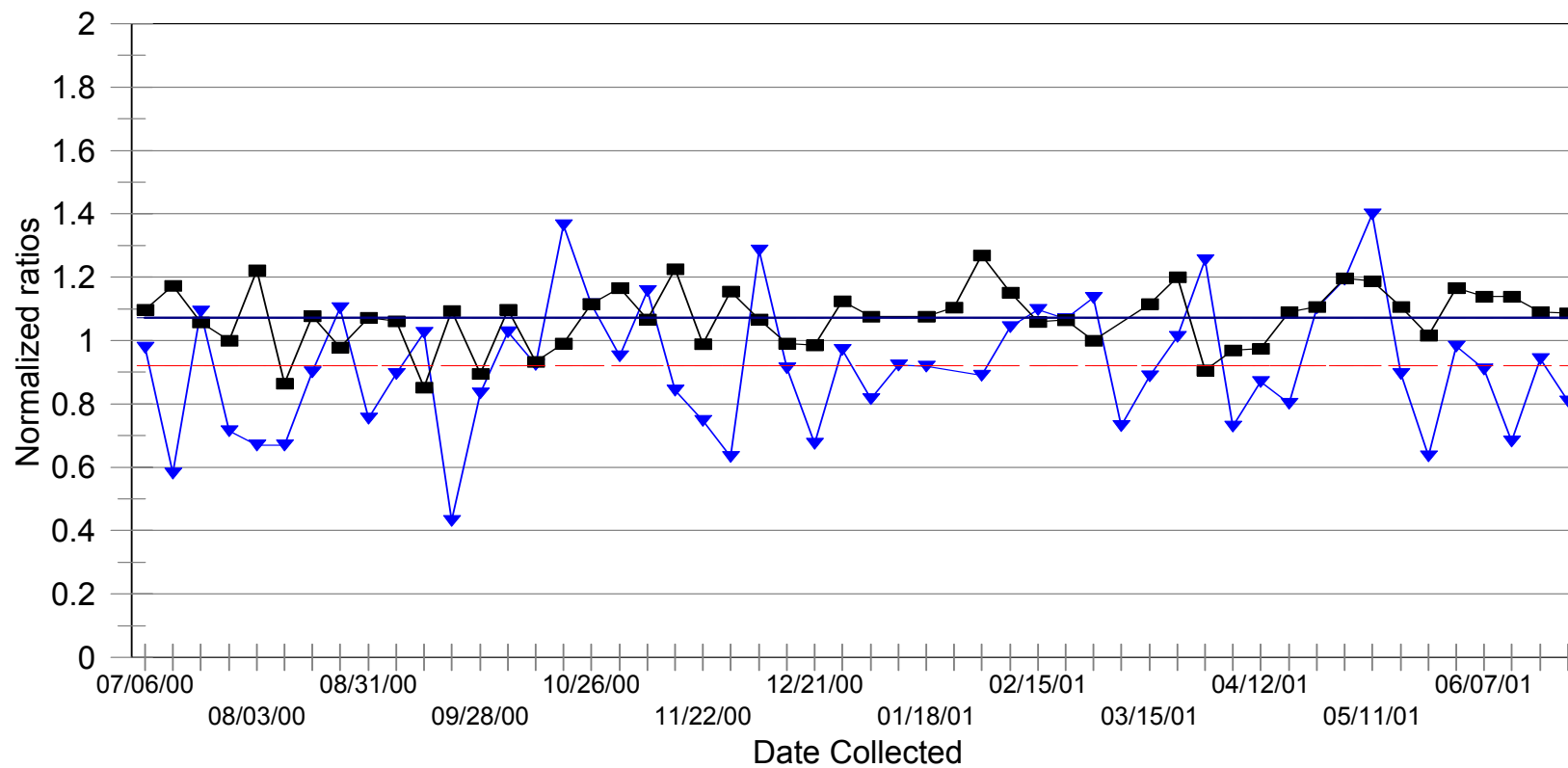
**WOLF CREEK GENERATING STATION
ENVIRONMENTAL RADIATION SURVEILLANCE REPORT
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GRAPHS

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Weekly Air Sample Comparison

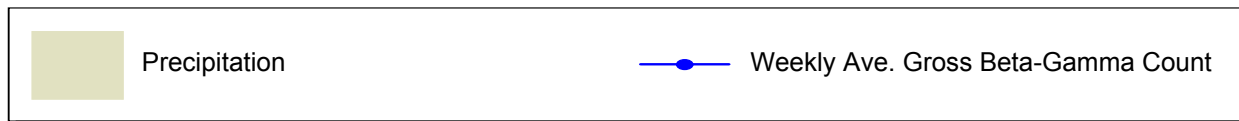
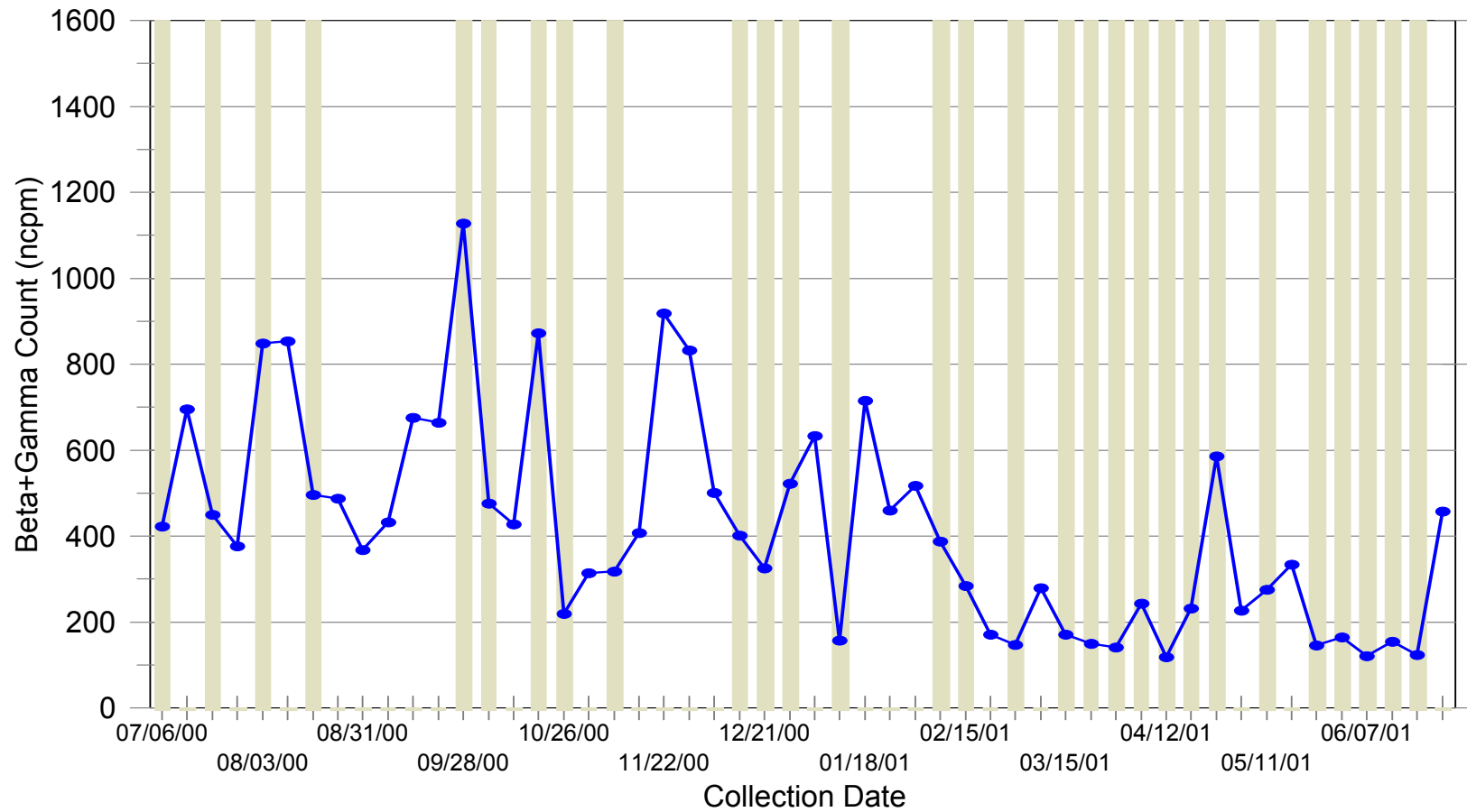
(Site averages/Control)



—▼— KDHE Weekly Average ratio —■— WCNOC Weekly Average ratio
 — KDHE Average ratio — WCNOC Average ratio

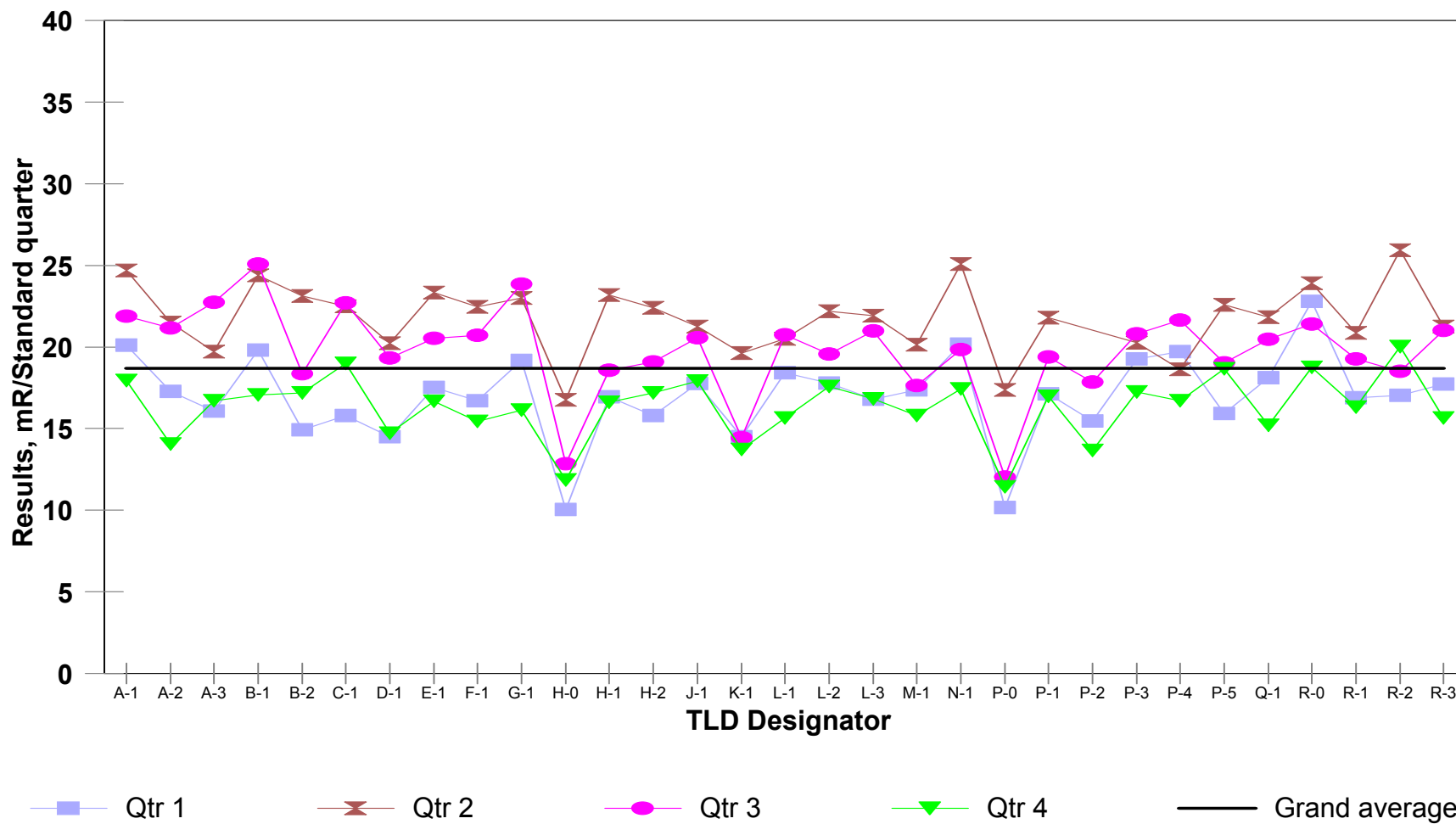
Graph 1.0 Weekly air particulate sample comparison.

Weekly Average Beta+Gamma Count



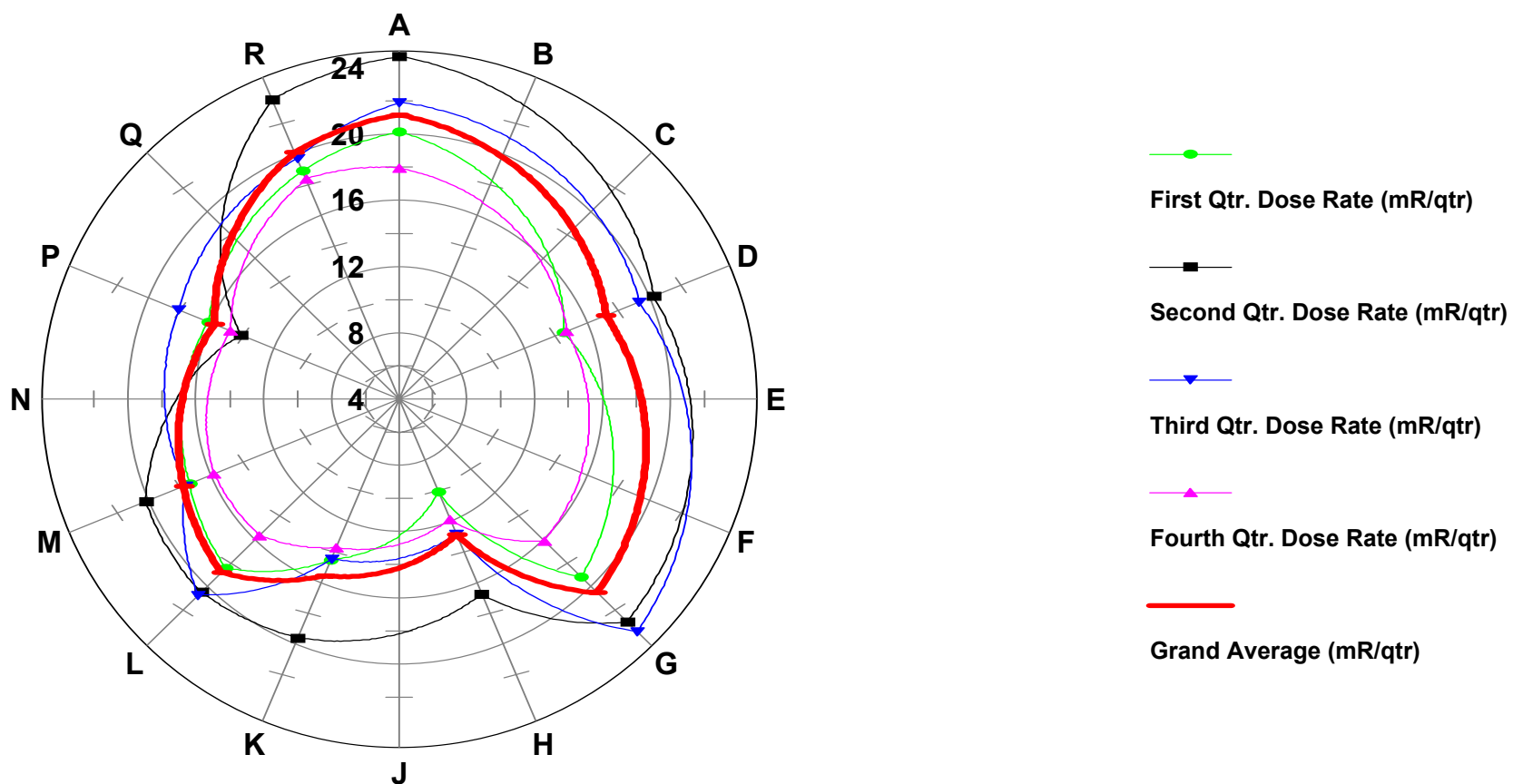
Graph 1.1 Weekly air particulate gross beta+gamma field counts

Wolf Creek direct radiation SFY 2001



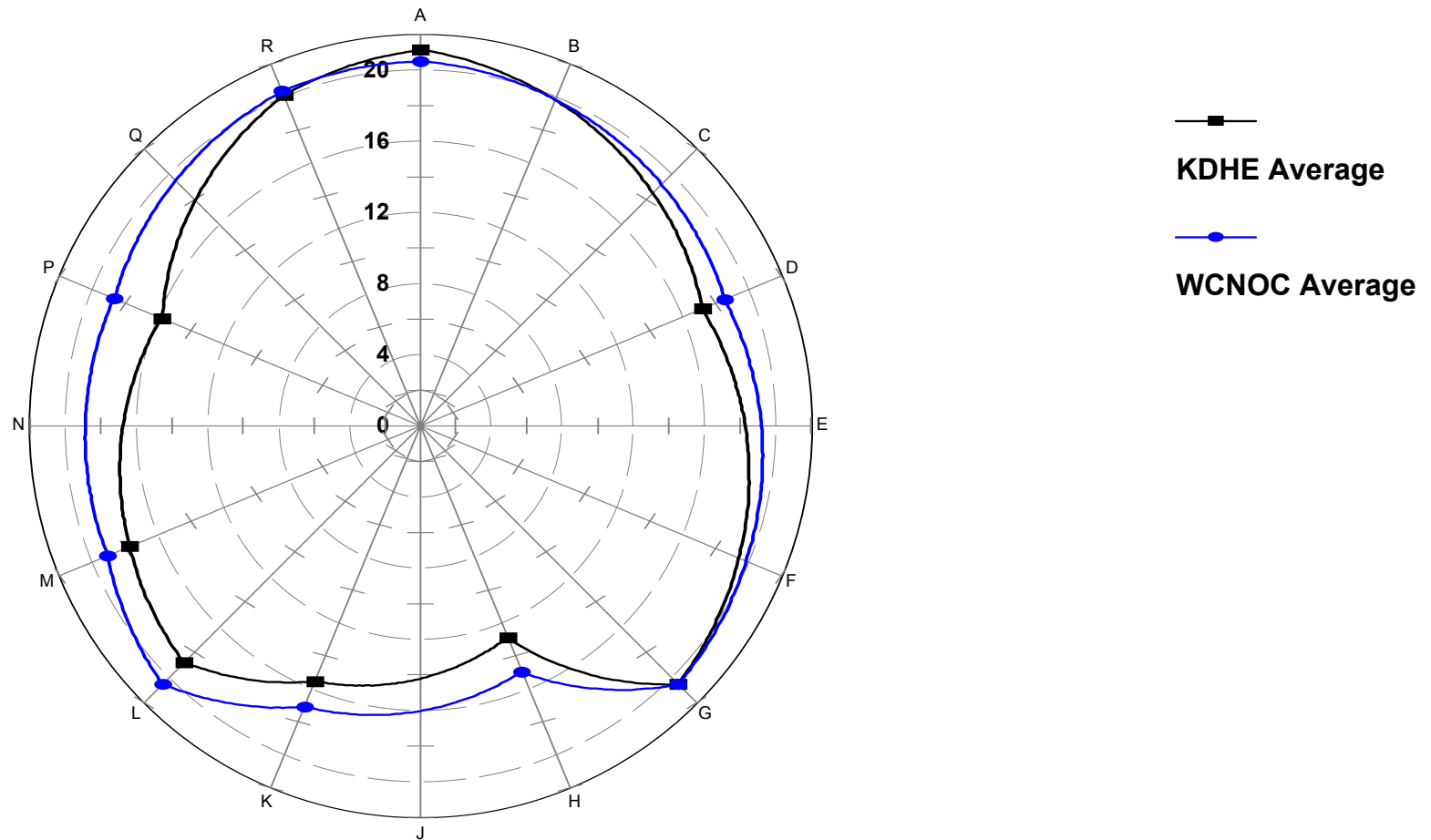
Graph 2.0 Quarterly direct radiation results for all KDHE TLD sites

Quarterly Direct Radiation Data Collocated Sites (By Sector)



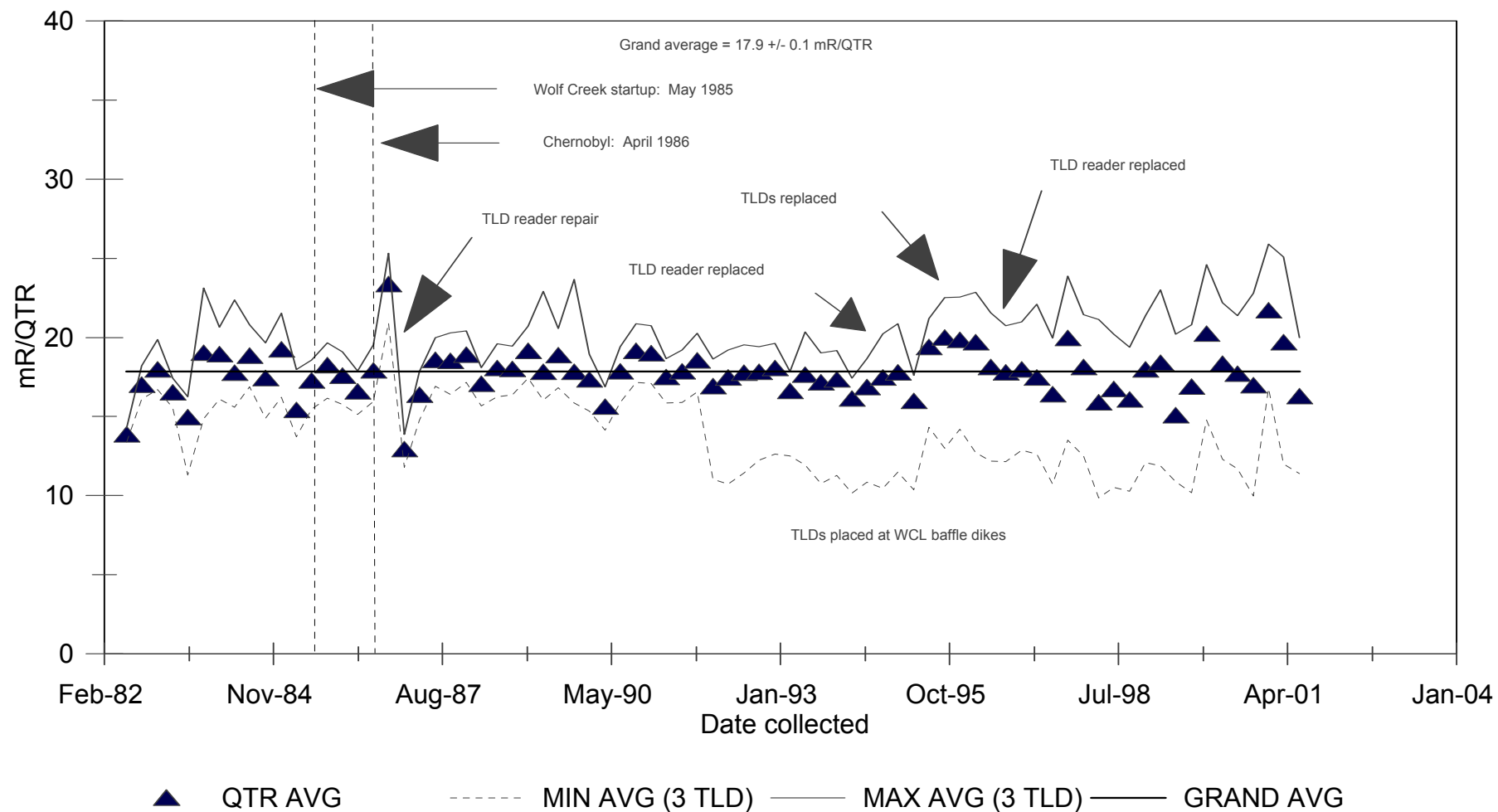
Graph 2.1 Quarterly direct radiation monitoring results for collocated TLD sites

Averaged Direct Radiation Levels Collocated Sites (mR/qtr)



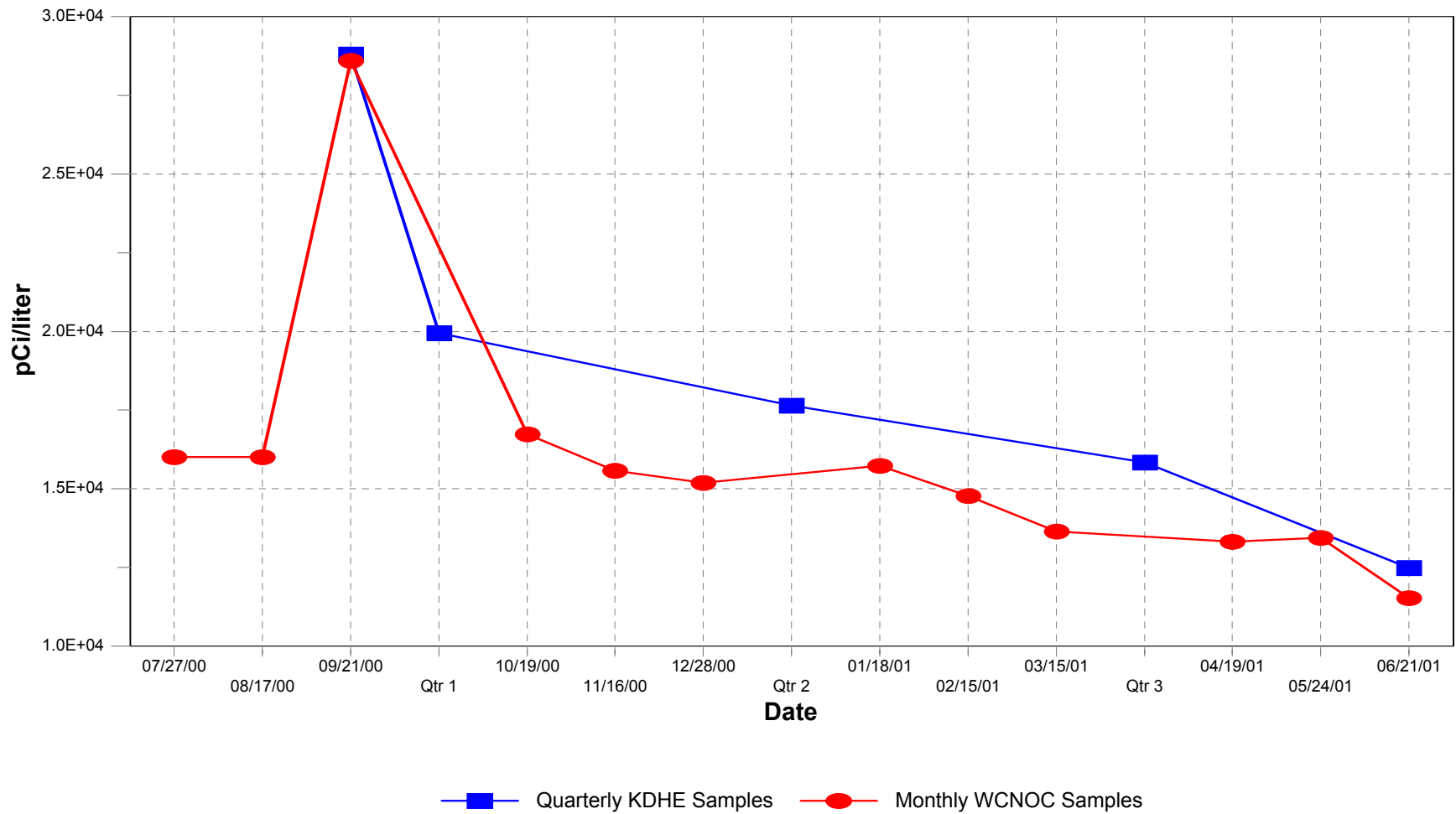
Graph 2.2 Comparison of WCNOC and KDHE average direct radiation readings for collocated sites

Historical TLD results Wolf Creek



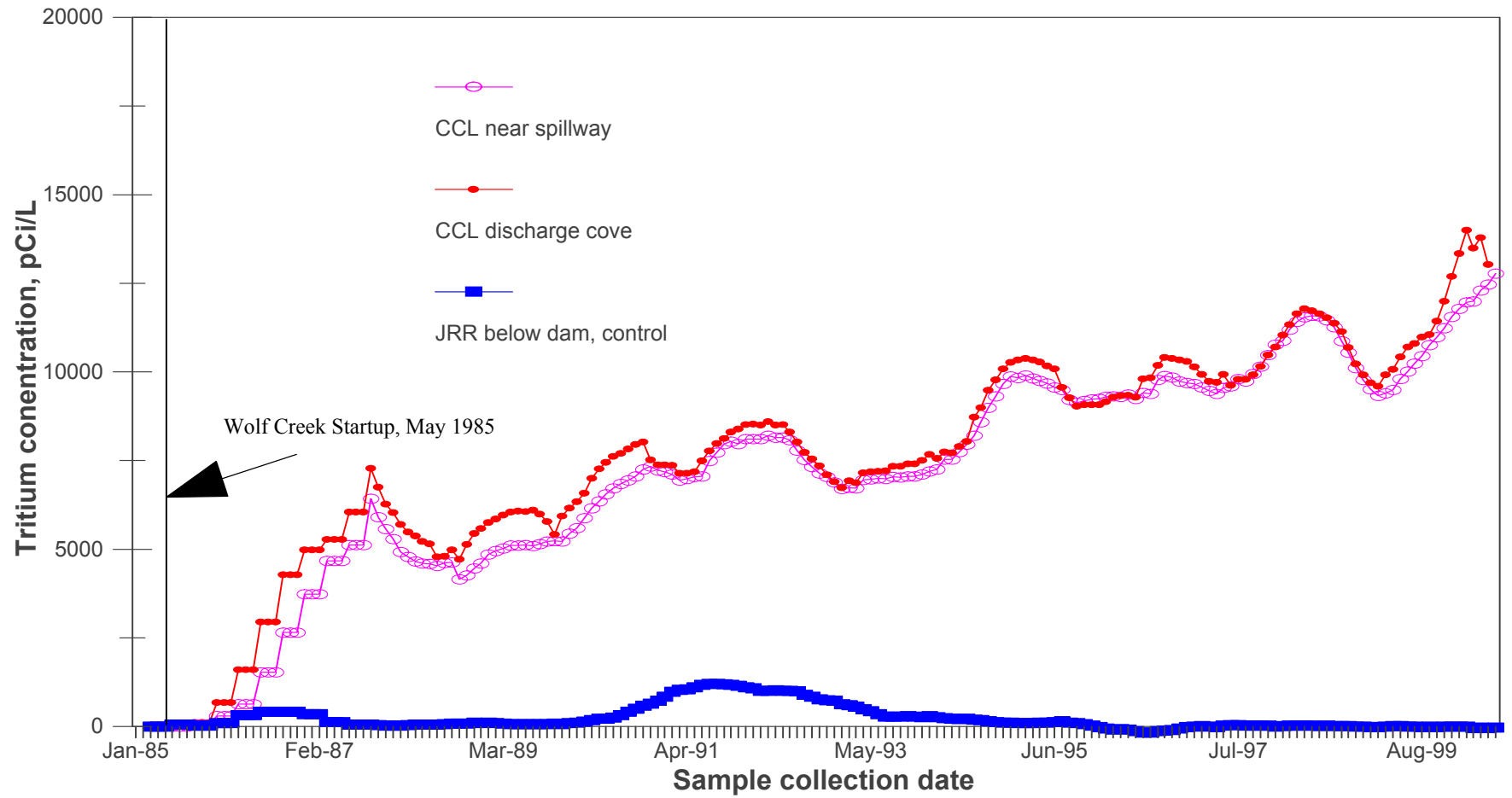
Graph 2.3 Historical KDHE direct radiation monitoring (TLD) results

Coffey County Lake Surface Water Tritium Concentration



Graph 3.0 Comparison of Monthly Surface Water Tritium Results.

Historical Surface water Tritium (H3) (12 month rolling ave.)



Graph 3.1 Historical KDHE Tritium Results.

**WOLF CREEK GENERATING STATION
ENVIRONMENTAL RADIATION SURVEILLANCE REPORT
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SFY 2001**

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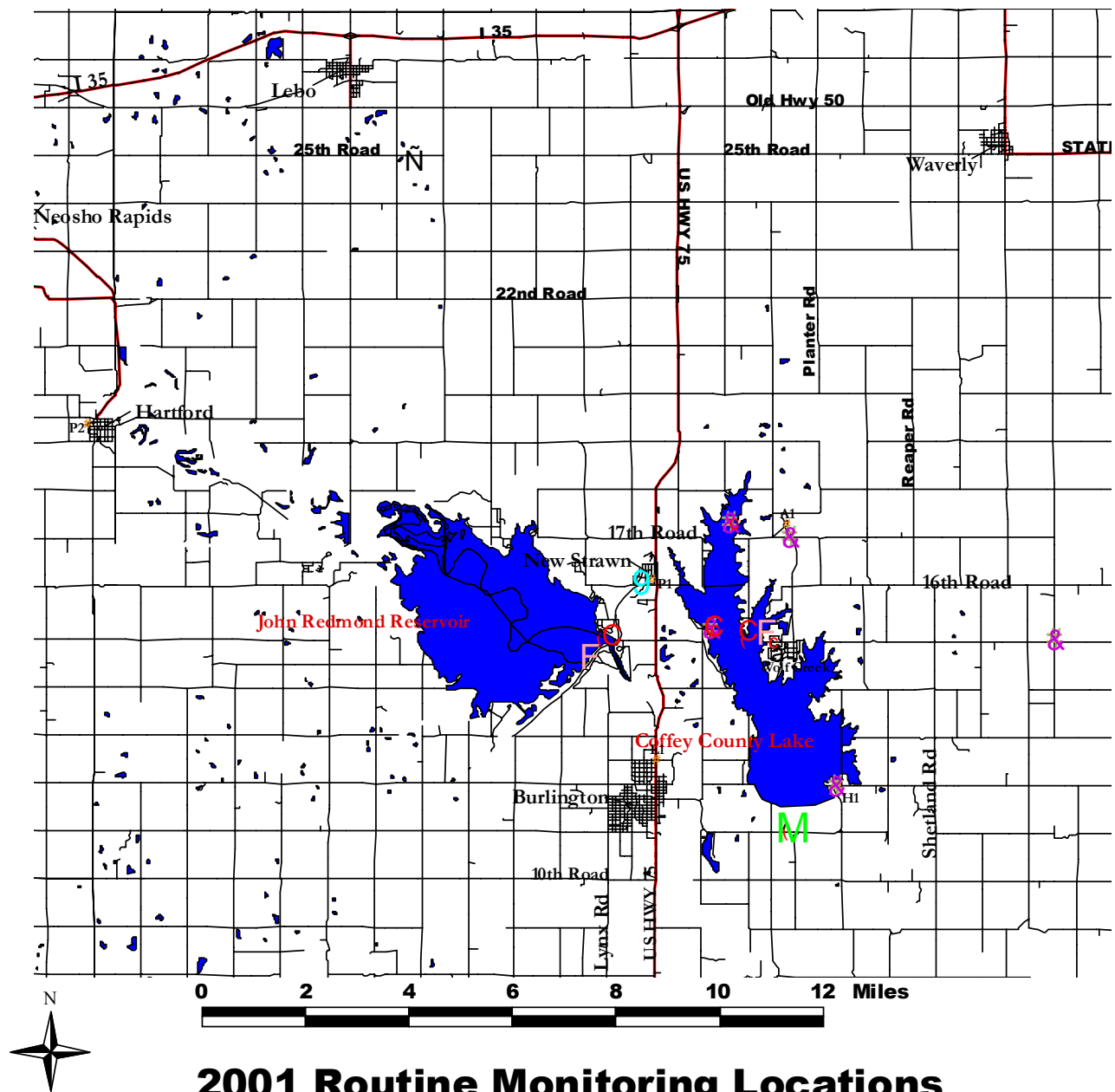
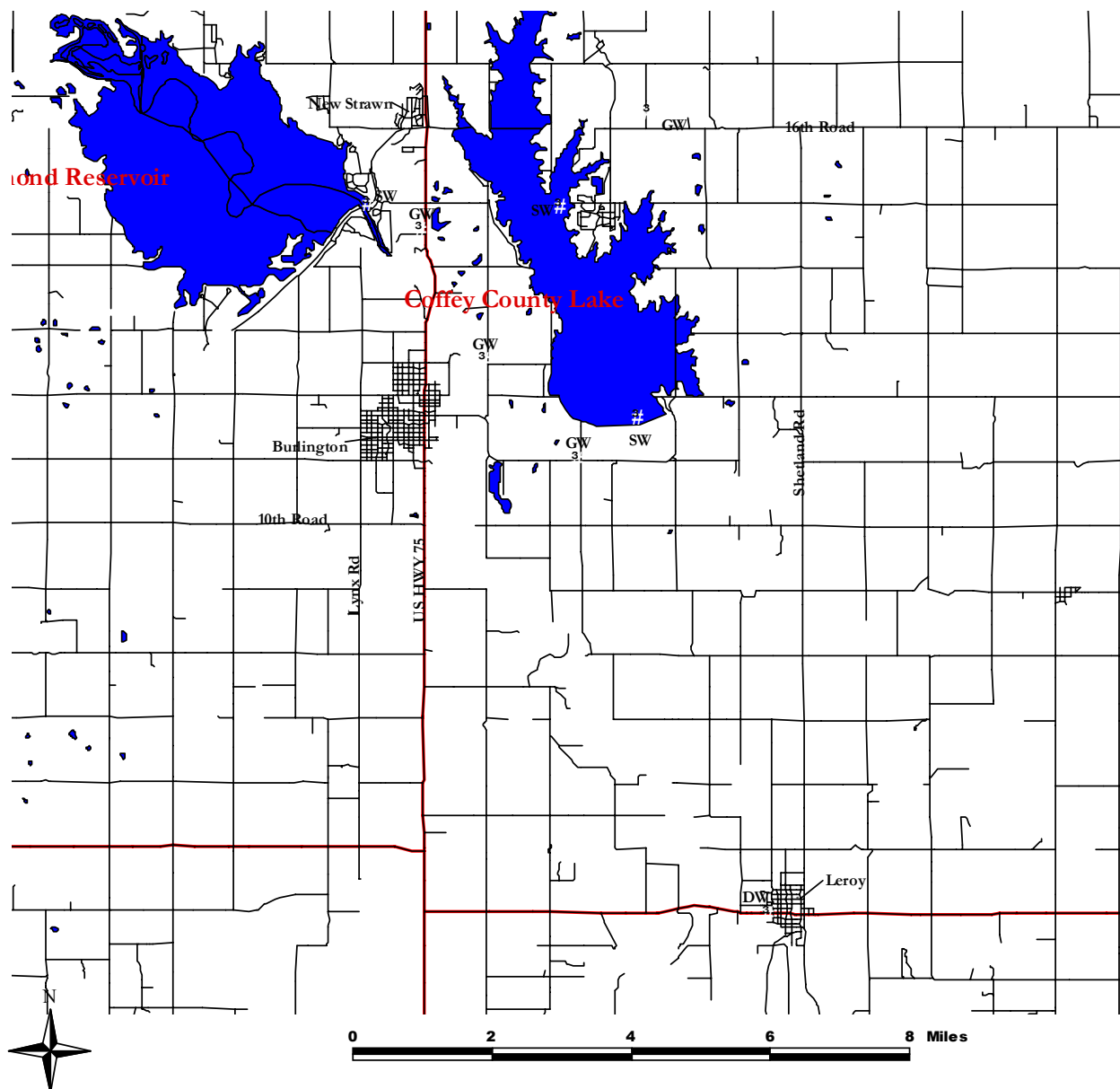


Figure 1.0 Routine Monitoring Locations

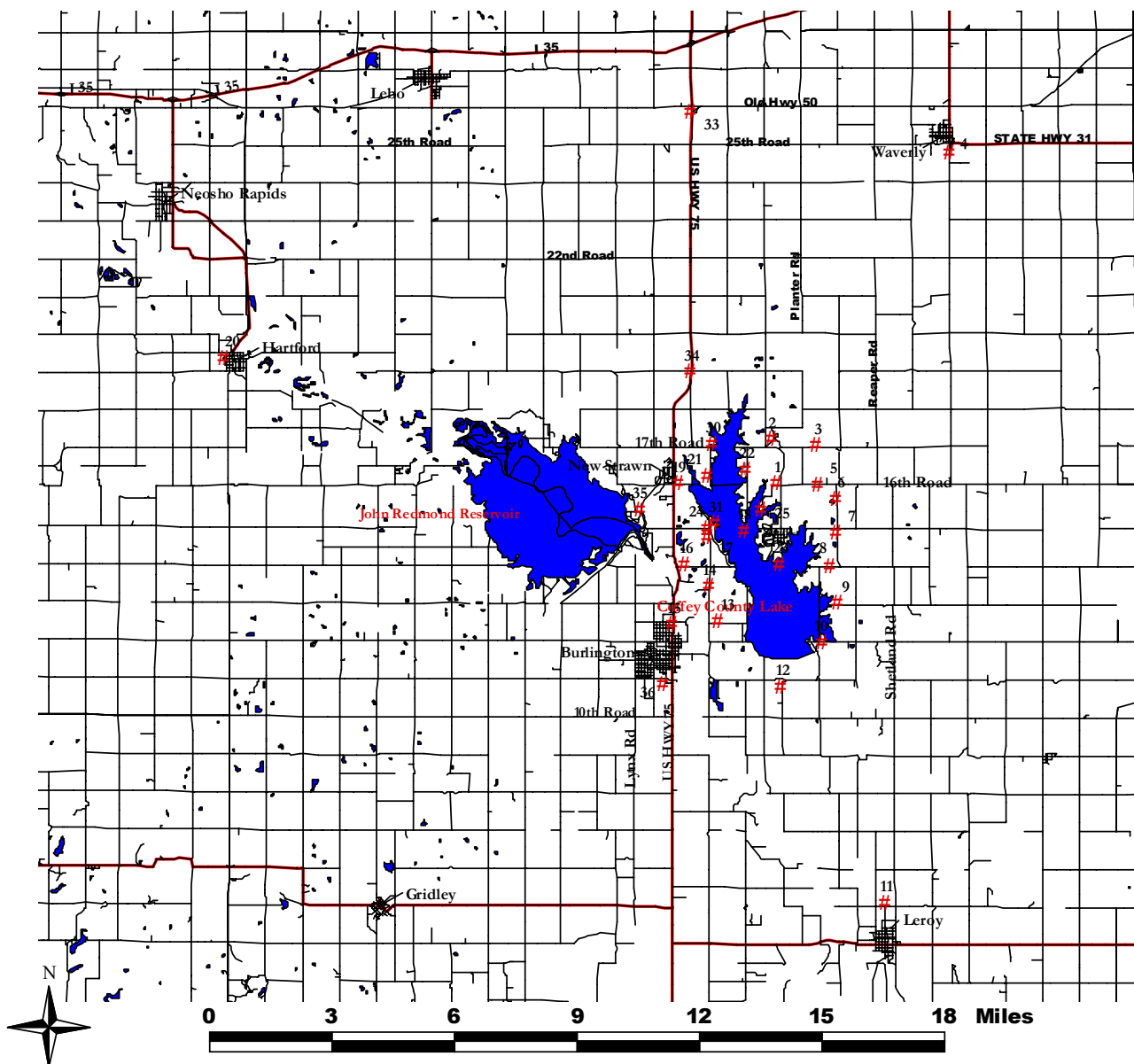


2001 Water Samples

³ **Water Samples**
 **Highways**

**Kansas Dept. of Health and Environment
 Radiation Protection Program
 Environmental Radiation Surveillance Program
 SFY 2001**

Figure 2.0 Routine Water Samples

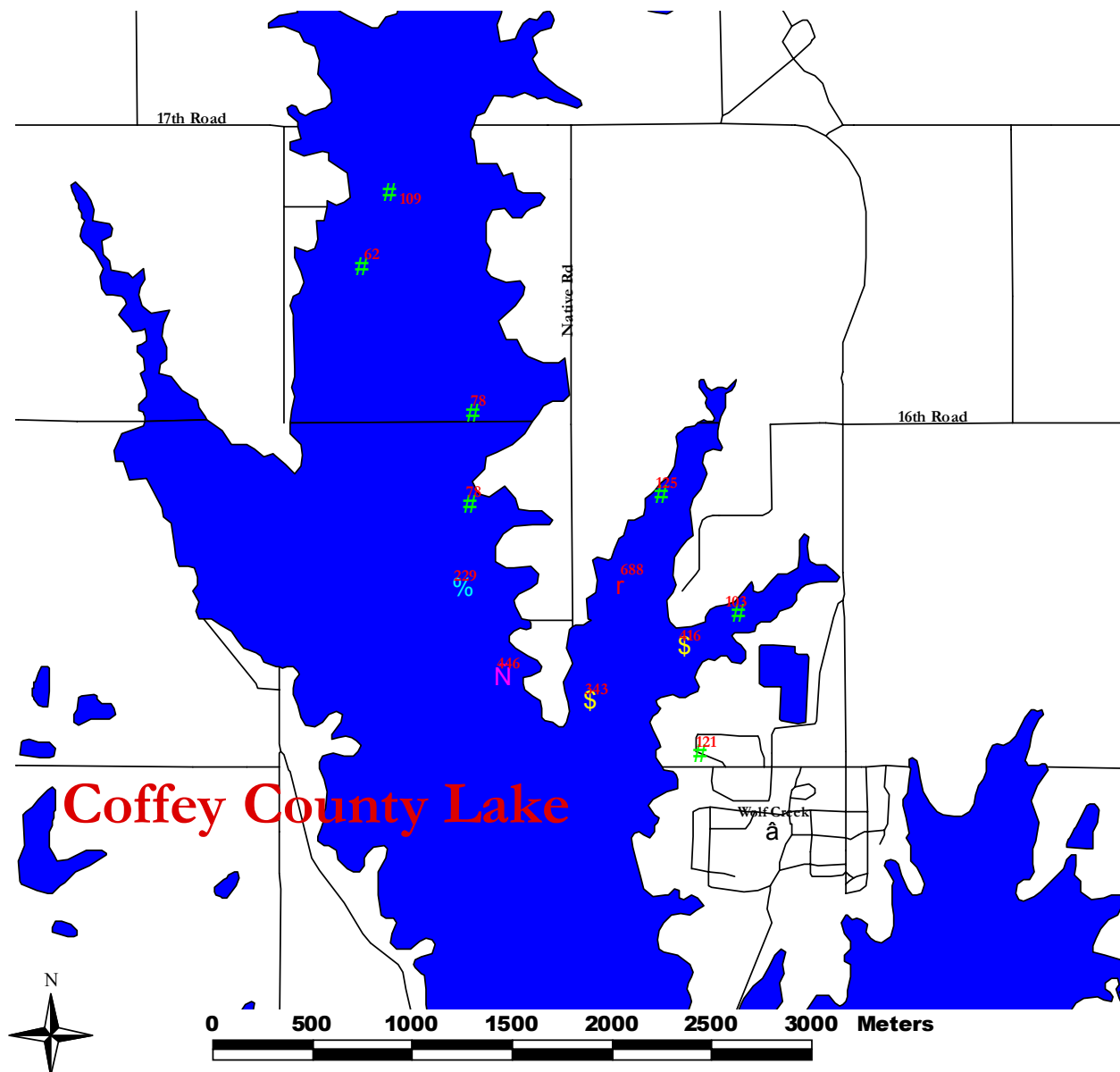


2001 Direct Radiation Monitoring Locations

â WCNGS
 # TLD Locations
 Highways

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Figure 3.0 Thermoluminescent Dosimeter Locations.

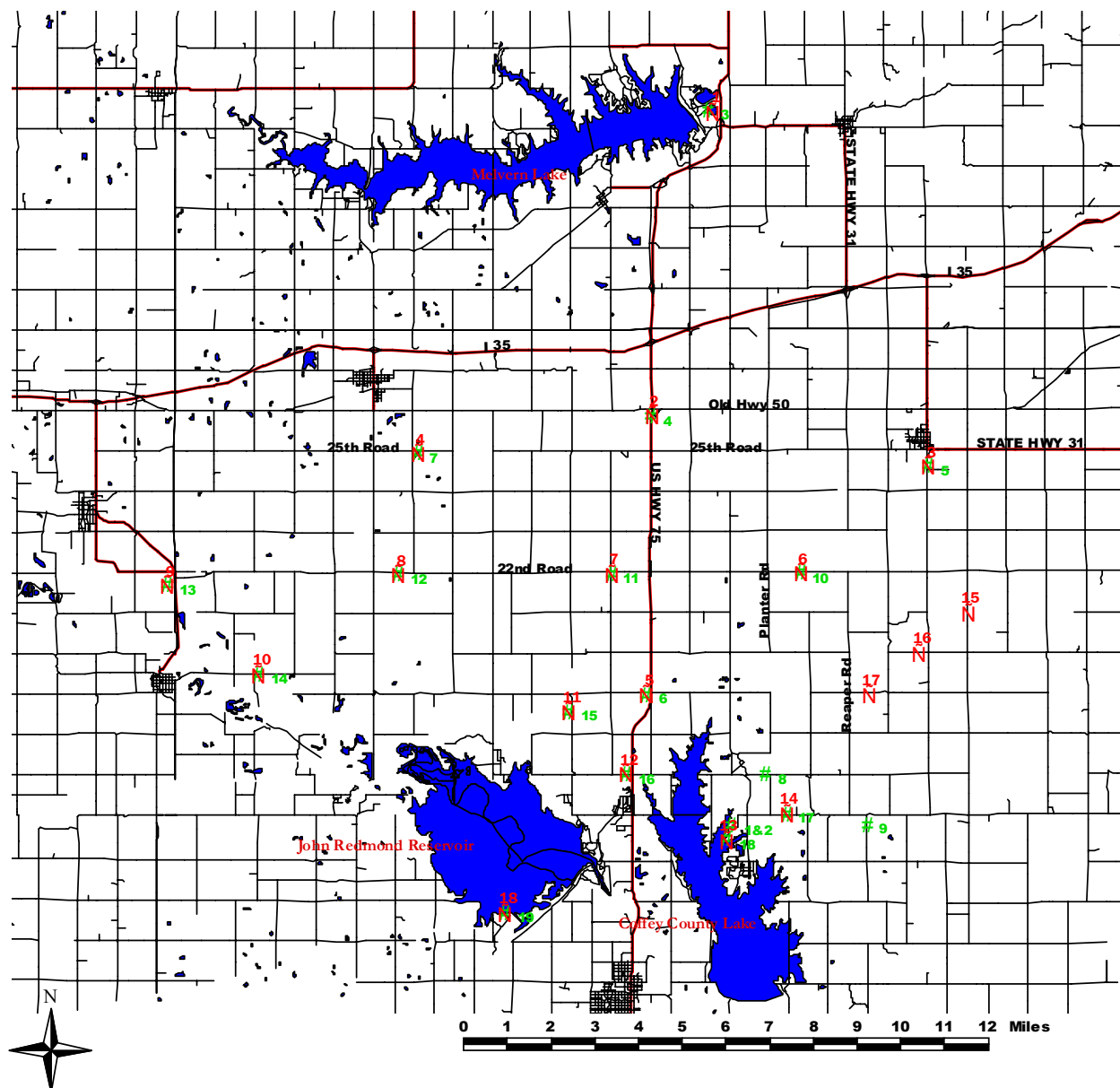


2001 Random Bottom Sediments Coffey County Lake Samples Only

â	WCNGS
Random Bottom Sediments (pCi/kg Co60)	
#	62 - 187
%	188 - 312
\$	313 - 437
N	438 - 562
563 - 688	
Highways	

Kansas Dept. of Health and Environment
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Figure 4.0 Coffey County Lake Random Bottom Sediments.



2001 Random Soil and Vegetation Samples

N Random Soil
 # Random Vegetation
 Highways

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Figure 5.0 Random Soil and Vegetation Samples.

